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Recommending Environmental Indicators and Identifying Common Barriers to Their Use for Companies in Costa Rica

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Abstract

Environmental indicators help companies monitor, evaluate, and mitigate their environmental impacts, but not all companies in Costa Rica make effective use of these tools. We worked with la Cámara de Industrias (CICR) in San Jose, Costa Rica to better understand the benefits, barriers, and best practices associated with the use of environmental indicators in Costa Rica. Our group interviewed and surveyed environmental experts and company representatives to determine specific applications of environmental indicators for Costa Rican companies. We developed a workbook to allow companies to easily track their environmental data using indicators, and we proposed recommendations to assist CICR in promoting the use of environmental indicators among their member companies.

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Our advisors, Professor Fabienne Miller and Professor Seth Tuler

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Executive Summary

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Introduction

Industrial practices are contributing to increased environmental health risks in developing countries (The World Bank, 2016). Industries with sustainable programs in place often use environmental accounting to quantify and reduce their negative impacts on the environment. Companies can utilize environmental accounting more efficiently by using environmental performance indicators. Although indicators can be useful, companies have faced challenges in defining and using them. According to Rosen et al. (2012) and Hák et al. (2012), the common challenges that companies face when adopting the use of environmental indicators are selecting which ones to use, a lack of resources to obtain data, and a fear of disclosing negative practices. Companies in developing countries, such as those in Costa Rica, may face additional barriers including a lack of educational, financial, and human resources (Jamil, Mohamed, Muhammad & Ali, 2015).

The Cámara de Industrias de Costa Rica (CICR), a private organization that represents the interests of 830 member companies, recognizes that its member companies struggle to make informed decisions with regard to their environmental impacts. The goal of this project was to assist CICR in promoting the use of environmental indicators by Costa Rican companies. The results of this project support this goal by providing information about the benefits, barriers and best practices of indicator use.

Background

Businesses use indicators to quantify information, provide meaning to information, and simplify complex systems (Nath et al., 2002). Companies specifically can use Environmental Performance Indicators (EPIs) to track how aspects of company operations impact the environment.

Environmental performance indicators improve internal and external communication about the status of, and changes to, a company's environmental impacts. Figure 1 summarizes the different roles EPIs play for various stakeholders.

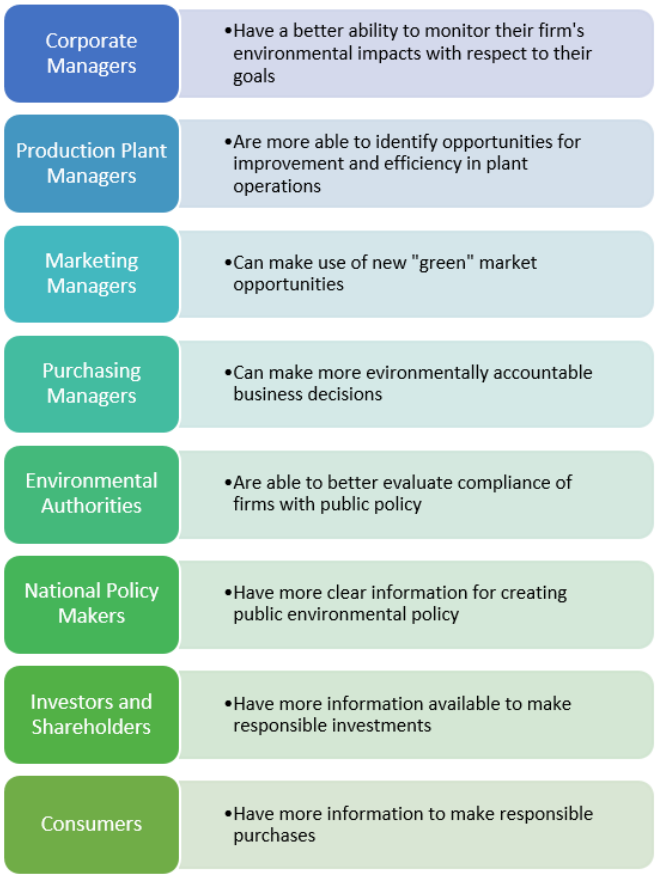

Figure 1: Roles of EPIs for Various Stakeholders

In order to be well informed on the range of applications of EPIs, we reviewed four frameworks that are global in scope from leading authorities in the field of environmental indicator reporting: The Global Reporting Initiative (GRI), The World Business Council for Sustainable Development (WBCSD), The National Round Table on the Environment and the Economy (NRTEE), United Nation Economic and Social Commission for Asia and the Pacific (UN ESCAP).

Methods

To accomplish our goal, we developed a research plan consisting of three objectives. Our data were gathered from two populations. The first population included experts in the field of corporate environmental responsibility. The second population included the 830 member companies of CICR, plus all companies that attend CICR training workshops.

Objective 1: Develop an understanding of environmental indicator use in Costa Rica from experts in the field

We conducted a series of interviews with five environmental consultants representing three private organizations: CICR, AED and ALIARSE. We asked environmental consultants targeted questions about the most commonly used environmental indicators, the barriers to their use, and the associated benefits.

Objective 2: Determine companies' current environmental data collection practices

We interviewed and surveyed company representatives from 30 Costa Rican companies. The survey inquired about whether or not companies collect the environmental data required for indicators proposed in the various frameworks identified in our literature review. In addition to the survey, we interviewed environmental managers of seven member companies of CICR. The interviews allowed us to gain more insight into what data each company collects, how the data are collected, and barriers associated with the process.

Objective 3: Determine how managers utilize and view the use of environmental indicators

We also interviewed management level executives of the same seven companies. We asked targeted questions about why they chose to use certain indicators, and the purposes that those indicators serve to the company. These interviews allowed us to gain insight into how companies use indicators to make decisions.

Completing these research objectives allowed us to gain an overall understanding of the current status of environmental indicator use among Costa Rican companies. Objective 1 allowed us to gain insights from environmental experts while Objectives 2 and 3 worked in conjunction to identify what type of environmental data companies collect and how that environmental data informs company decisions.

Findings

There are three main benefits for companies using environmental indicators: compliance with governmental regulations, improvement of company efficiency, and increased marketability

Certain indicators are required for compliance with governmental regulations. The importance of using indicators to demonstrate compliance was discussed by five of the seven companies and three of the five consultants that we interviewed. Different indicators are needed for compliance depending on economic sector and type of business operation, including food production, the use of boilers, and the treatment of wastewater.

Internal company efficiency can be improved through the use of indicators. Using indicators to monitor individual company processes allows companies to identify areas that use the largest quantities of resources and target these areas for improvement. For example, a food production company that we interviewed reported that they reduced water expenses by 40% once they started using indicators to monitor their processes.

The use of indicators can help in companies' marketability. Companies are able to use information regarding their environmental impacts to market themselves to green consumers and clients. In particular, companies are able to acquire nationally and internationally recognized environmental certifications. Indicators are important for companies that are considering applying for certifications because they provide information necessary to receive them.

Companies often lack motivation to use environmental indicators

Environmental consultants suggested that companies do not use environmental indicators because the investment required for data collection outweighs any perceived benefits. Additionally, they stated that regulatory bodies and consumers aren't strongly demanding the reporting of environmental data. Experts noted that companies tend to only get certifications when they are required to be competitive, and

that there are currently no government incentive programs to encourage the use of indicators.

Companies often fail to educate employees regarding the use of environmental indicators

Operations are improved when multiple levels of employees throughout the company understand the role indicators can play in a company's success. From the production worker who is responsible for utilizing the resources being measured to the top-level manager making decisions based on the indicators, an understanding of the purpose of the data and indicators is key to the success of indicator-based decisions. An environmental consultant noted that because not all environmental data depends on one person's actions, all employees must be properly educated on the subject.

Companies often fail to communicate internally about environmental issues

The environmental consultants we interviewed raised questions about the collection and distribution of environmental data within companies. The communication barrier was reflected in our survey as well. There are four companies who had two employees respond to the survey, and no two pairs of employees from the same company had the same survey response.

Companies often lack the human and financial resources necessary to use environmental indicators

Lack of resources refers to limitations in both human and financial resources, and applies more to smaller companies than it does to large enterprises. Larger companies are more likely to have the financial resources and employees to dedicate to environmental projects. Collecting data takes time, and investing in the equipment to measure data at the process level requires an investment that SMEs may not be able to make. Our survey responses showed only a marginal difference between the types of data that SMEs and large companies collect. However, the survey only asked companies whether they collect a certain type of data, not how often or how specific the data are, which is where we would expect to see differences based on company size.

Companies often lack the necessary infrastructure for acquiring environmental data

Measuring equipment associated with collecting environmental data is often considered expensive. Additionally, retrofitting this equipment into an existing facility is also costly, and at times is simply not feasible given physical restraints of facilities. As a result, many companies rely on low frequency (monthly, semi-annually or even yearly) manual measurements or data from company invoices, making the data less valuable for continuous process improvement.

There are four indicator categories that companies and experts identified as the most important: electricity, water, fuel, and waste

Consumption of electricity, water, and fuel, and the disposal of waste represent costs that affect all companies in Costa Rica. These four indicator categories can provide baseline information about a company's environmental impacts. However, the relative importance of the four categories can vary in significance among companies. These four categories are also emphasized in the indicator frameworks reviewed in our background research, representing 30 of the 70 indicators from the four frameworks.

There is a disconnect between companies and environmental consultants on the importance of measuring carbon footprint

Measuring carbon footprint was mentioned by all five environmental experts that we interviewed, but only by three of the seven companies. Two of those companies are certified as carbon neutral, and the third is working toward achieving this certification. This disagreement suggests a disconnect between the country's goal and the practices of companies.

Recommendations

CICR should identify and classify their member companies by level of environmental performance

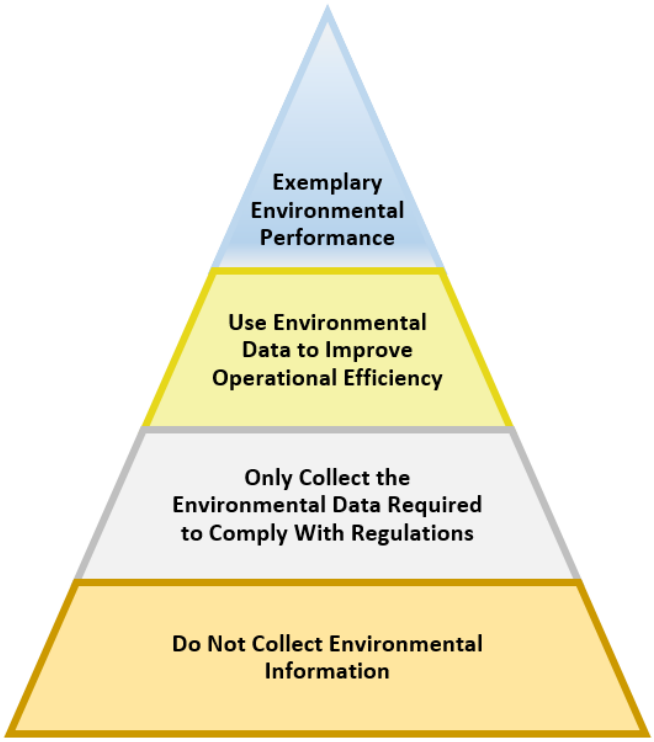

Figure 2: Four Levels of Environmental Performance

We recommend that CICR implement a four level system to categorize their member companies with respect to environmental performance, as shown in Figure 2. By organizing companies with this structure, CICR will be able to target appropriate resources, such as training sessions and informational bulletins, at each level and support companies to initiate and improve environmental programs.

CICR should provide training to its member companies that facilitate the process of using environmental indicators

Training sessions should be targeted at instructing companies on how to acquire environmental data, defining useful environmental indicators, how to calculate them, and how to better utilize environmental indicators in decision making. Training sessions can be geared towards the four levels of environmental performance. For example, trainings for middle-tier companies would highlight using indicators to increase operational efficiency and how to acquire data at a more specific process level.

CICR should develop and disseminate user-friendly resources to its member companies that encourage the adoption of environmental indicators

While CICR has collaborated with multiple partners to produce detailed environmental guides for their member companies, we believe that additional user-friendly resources would be beneficial. For example, a basic indicator workbook for SMEs can help them organize, record, and normalize their environmental indicators, and compare their performance over time Another useful resource could be a carbon footprint calculator that helps companies more easily estimate their carbon footprint based on environmental data that they already have.

CICR should support the development of government programs that encourage the use of environmental indicators

We recommend that CICR lobby the Costa Rican government to create incentive programs that reward companies for positive environmental performance. There has already been some development in these areas, including a new water law intended to reduce a company's water tariff if the company shows progress in reducing water consumption.

Conclusion

This work has identified barriers Costa Rican companies encounter when trying to use environmental indicators, and has detailed actions CICR can take to help its member companies. We intend for these results to help companies mitigate their negative environmental impacts, and to help increase the overall environmental sustainability of the Costa Rican industrial sector. Costa Rica is viewed by many as an example for sustainability. With improvements to their use of environmental indicators, Costa Rican industries can continue to set a standard for sustainable development on a global stage.

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Chapter 1: Introduction

Industrial practices are contributing to increased environmental health risks in developing countries (The World Bank, 2016). The negative effects of industrial practices include air pollution, lead poisoning, water contamination, poor sanitation, and hazardous waste. These impacts cause illness, damage ecosystems, hinder economic growth, and worsen the impacts of poverty for both urban and rural populations (The World Bank, 2016).

Costa Rica has especially suffered these harmful effects of industrial pollution. For example, in Costa Rica's Gulf of Nicoya, wastewater pollution stemming from the industrial San Jose area is currently endangering local ecosystems (Symonds et al., 2017). This pollution presents health concerns to the local population, damages the national fishing industry, and impacts tourism of the area (Symonds et al., 2017). As similar situations exist elsewhere in the country, improving the sustainability of industry becomes magnified.

In Costa Rica, minimizing harmful impacts on the environment is a national focus. Article 50 of the Costa Rican Constitution, for example, specifically protects "the right to a healthy and ecologically balanced environment." Laws also represent national efforts to mitigate environmental and public health impacts from industrial activities. Costa Rican legislation in support of environmental protection includes the Payment for Environmental Services (PES) reforestation program, a strict water tariff, and Forestry Law 7575, which recognizes focal points for environmental protection (Pagiola, 2008; FONAFIFO, 2016). In addition to government policies and regulations, some companies in Costa Rica have voluntarily established progressive environmental sustainability programs. For example, 63 companies in Costa Rica are currently carbon neutral certified (MINAE, 2017). However, for a country that has the goal of becoming carbon neutral, this small number of carbon neutral companies leaves much room for improvement.

Companies with programs for sustainability in place often make use of a concept known as environmental accounting, which is a way for companies to quantify their environmental impact. However, environmental accounting is complex in nature and often difficult for companies to use in making decisions (Nath, Hens, Compton, & Devuyst, 2002). One way for companies to utilize environmental accounting more efficiently is to use indicators. Indicators are a condensed form of data that provide meaningful information to a decision maker (Olsthoorn, Tyteca, Wehrmeyer & Wagner, 2001). Without indicators, environmental accounting data can be relatively useless for making decisions (Japanese Ministry of the Environment, 2003).

Although indicators can be useful, companies have faced challenges in defining and using them. Barriers to their use include a lack of data, absence of a framework for organizing and reporting indicators, and an inadequate selection of indicators (Rosén, Lindner, Nabuurs, & Paschalis-Jakubowicz, 2012; Hák, Moldan,& Dahl, 2012). Companies in developing countries, such as those in Costa Rica, may face additional barriers including a lack of educational, financial, and human resources (Jamil, Mohamed, Muhammad, & Ali, 2015). The Chamber of Industries in Costa Rica (CICR) is working to help companies overcome these barriers. CICR, a private organization that represents the interests of 830 member companies, has recognized that Costa Rican companies struggle to make informed decisions regarding their environmental practices. They have also identified that adopting the use of indicators can be difficult, and that companies often encounter barriers during the process.

The goal of this project was to assist CICR in promoting the use of environmental indicators in Costa Rican companies by better understanding the benefits, barriers, and best practices of their use. Our objectives for accomplishing the goal were:

1. To develop an understanding of environmental indicator use in Costa Rica from experts in the field
2. To determine companies' current environmental data collection practices
3. To determine how managers utilize and view the use of environmental indicators
4. To synthesize and effectively communicate our recommendations

To accomplish these objectives we investigated several companies, the majority of which were manufacturing companies that are members of CICR. We found that while some companies in Costa Rica have successfully incorporated environmental indicators into their business models, there are companies that still struggle to understand the full benefits of their use. We also learned that the government requires reporting of certain obligatory indicators. However, for companies to fully integrate environmental indicators into their business practices, they must perceive the benefits of their use. As a result, we developed recommendations for CICR to help facilitate the future education of companies about the benefits of using environmental indicators. These recommendations include classifying companies by their use of indicators for more targeted assistance, lobbying the government for programs that encourage the use of indicators, providing resources to make using indicators easier for companies, and providing training for companies to use indicators for marketing. Finally, we suggest that CICR investigate the lack of reporting of environmental indicators within their corporate awards program.

Chapter 2: Background

In this chapter we first focus on current sustainability practices in Costa Rica, and their importance to the well-being of the country. We then demonstrate how companies in general play a major role in sustainability, and we go on to describe environmental accounting and its importance to evaluating the environmental sustainability of companies. This is followed by a discussion of the key roles environmental indicators play in environmental accounting. Lastly, we identify characteristics of good environmental indicators in business, and explore environmental indicator frameworks that are currently used worldwide.

2.1 – Sustainability in Costa Rica

The Costa Rican government has historically made environmental sustainability a priority. For example, the government has previously expressed its goal for Costa Rica to become a carbon neutral nation by 2021 (Kaygusuz, 2007). However, a 2015 report by the Costa Rican Ministry of Environment and Energy (MINAE) has declared that the target date for carbon neutrality has been delayed to 2085, showing that there are remaining challenges to sustainable development (MINAE, 2015).

2.1.1 – Benefits of Sustainability in Costa Rica

Costa Rica's sustainability efforts are largely aimed at the protection of its rich ecosystems. The country's economy benefits from healthy ecosystems as the growing ecotourism industry accounts for 12.5% of Costa Rica's GDP (Chiesa, Crotti, & Lengefeld, 2013). In 2001, international tourist arrivals were reported at just over 1 million. In 2013, this number grew to over 2.4 million (Costa Rica Tourism Board, 2013). Growth in tourism has been directly attributed to the country's landscape beauty and rich biodiversity (FONAFIFO, 2016). Additionally, the preservation of Costa Rica's biodiversity benefits scientific research and the pharmaceutical industry, which was projected to account for 1.6% of the country's GDP in 2016 (FONAFIFO, 2016; BMI, 2016).

Sustainability initiatives in Costa Rica also aim to protect citizens from the negative social impacts of industrial pollution. For example, wastewater pollution is currently endangering the local ecosystems in Costa Rica's Gulf of Nicoya (Symonds et al., 2017). The Gulf of Nicoya provides 30% of the country's seafood, and as a result this water pollution has indirect effects on national health, and both local and national economies. It is also interesting to note that this wastewater does not originate from local sources, but rather 70-80% stems from rivers surrounding the densely populated and industrial San José area, showing that environmental impact is not restricted to the vicinity of its source (Symonds et al., 2017).

2.1.2 – Costa Rican Government's Efforts Toward Sustainability

The Costa Rican government has implemented legislation to mitigate the negative impacts of unsustainable practices. For example, to protect the Costa Rican environment for both economic and social reasons, Forestry Law 7575 defines the reduction of greenhouse gas

emissions, protection of watersheds, protection of biodiversity, and preservation of landscape beauty as target areas to mitigate impacts of industrial practices (FONAFIFO, 2016).

The Costa Rican government also regulates water-usage. In 2005, the country revised and significantly increased the water tariff charged to consumers. The revenue generated from this increase is used in part to finance the Payment for Environmental Services program (PES), which financially incentivizes reforestation programs (Pagiola, 2008). In addition to generating revenue, this tariff suggests a trend toward more compulsory environmental services, rather than voluntary ones. The change to compulsory payments has the potential impact of increasing the amount of funding available for the program (Pagiola, 2008). The tax on water-usage also incentivizes the protection of watersheds, which are valuable sources of hydropower, as more than 88% of the electricity produced in Costa Rica is generated from hydropower or other renewable resources (The World Bank, 2014).

2.1.3 – Disconnect Between National Goals and Commercial Practices

Although Costa Rica has made important strides toward sustainable development through legislation, these efforts have not been reflected in all companies' practices. The Chamber of Industries in Costa Rica (CICR) has specifically identified this lack of progress in their member companies. The results of a recent survey conducted by CICR showed that many of its member companies do not have an effective method of measuring the environmental impact of their business practices (M. Blandino, personal communication, November 21, 2016). This was also demonstrated in the low participation in CICR's annual corporate award program, the "Premio a la Excelencia," which includes two sections concerning environmental sustainability. In 2015, only nine out of CICR's 830 member companies submitted information for these sections (Arias, 2015). CICR would like to recognize companies for their commitment to environmental sustainability, but with so few companies participating there is concern around how well companies are measuring their environmental impact.

2.2 – Environmental Accounting for Companies

If companies neglect to assess their environmental impacts, these impacts become externalities to their operations. An externality is an effect of a business operation that impacts other parties without being economically accounted for by the company themselves (Marcus & Rijsberman, 2003). Environmental accounting is a technique for companies to internalize environmental externalities, and to communicate environmental impact by extending traditional accounting models to include environmental data (Lamberton, 2005). Environmental accounting allows a company to identify negative externalities, which can help them establish policies, procedures, and processes that reduce their environmental impact (Goodwin, 2007). The next two sections will address the benefits of environmental accounting for companies, as well as challenges companies face when implementing environmental accounting.

2.2.1 – Benefits of Environmental Accounting

Benefits of environmental can be external to the company or internal to the company. The primary external benefit is to positively affect a company's image and reputation; a recent survey

investigating global consumer trends of over 30,000 consumers worldwide revealed that 55% of consumers are willing to pay more for products from socially and environmentally responsible organizations (Servaes & Tomayo, 2014).

Internal benefits can be grouped into three categories: better assessment of opportunities to save money, more informed pricing and product decisions, and more environmentally friendly practices (Christ and Burritt, 2013). These benefits can help increase a company's operational performance, efficiency, and overall sustainability (Ernst & Young LLP and Boston College Center for Corporate Citizenship, 2013).

2.2.2 – Potential Barriers to Environmental Accounting

While the process of environmental accounting has clearly discernable benefits, not all companies take advantage of this technique. Environmental accounting requires a significant allocation of resources, and companies often lack the motivation and incentives to pursue its implementation (Lamberton, 2005). Furthermore, accurately measuring environmental impact requires a large amount of detailed data. These data sets are often difficult for decision makers to interpret and use, and are largely meaningless on their own (Nath et al., 2002). Making informed decisions related to environmental accounting is assisted by condensed, interpretable forms of data known as indicators (Olsthoorn, Tyteca, Wehrmeyer & Wagner, 2001).

2.3 – Indicators for Environmental Accounting

Indicators are used in business as a method of quantifying information, providing meaning to information, and simplifying complex systems (Nath et al., 2002). Key performance indicators (KPIs) are the business terminology used to refer to indicators that provide decision-makers with information about the status of their businesses. They are used to measure progress toward goals or targets that a business would like to reach, such as a 10% growth in annual sales, or a 3% decrease in the production time of a single unit of product. Environmental Performance Indicators (EPIs) are the environmental corollary of KPIs, and are used to track how aspects of a company's operations impact the environment.

In the following sections, we examine attributes that are characteristic of good KPIs and EPIs. We then detail how indicators are classified, and why EPIs are important to businesses for evaluating sustainability. Finally, we analyze four environmental indicator frameworks used for businesses, and explore barriers that have previously been encountered when trying to use environmental indicators.

2.3.1 – Characteristics of Good Indicators

Quality indicators are the key to interpreting and making sense of complex relationships for effective decision making. The most established method for evaluating the quality of KPIs is called the SMART method, proposed in 1981. While there are multiple interpretations of what the initials stand for, a common interpretation of SMART is: Specific, Measurable, Accessible Data, Relevant, and Timely (Frey & Osterloh, 2013; Piskurich, 2015; Shahin & Mahbod, 2007). EPIs share many similar characteristics with KPIs, but also have specific characteristics that

make them more relevant to environmental issues. Table 1 shows how evaluation criteria specifically for environmental indicators corresponds to the attributes identified by the SMART method. The listed EPI evaluation criteria are from the World Business Council for Sustainable Development (WBCSD) (Verfaillie & Bidwell, 2000), the Japanese Ministry of the Environment (JME) (Japanese Ministry of the Environment, 2003), and the International Society of Sustainability Professionals (ISSP, n.d.). The three organizations were selected based on their advanced work in the area of sustainable development.

KPI Criteria	**EPI Criteria**		
SMART	**WBCSD**	**JME**	**ISSP**
Specific – the indicator should be focused on a specific, meaningful target	• Clearly defined, transparent, and verifiable		
Measurable – are the data quantifiable?	• Measureable	• Comparable among different companies	
Accessible Data – are the data available and valid?	• Verifiable by third parties • Transparent	• Accessible data • Verifiable by third parties • Reliable	• Accessible data • Reliable
Relevant – does the indicator link to the company's strategy? Will the company use the information from the indicator to make decisions?	• Protects the environment, human health, and/or improves quality of life • Informs decision making • Understandable to stakeholders	• Relevance – importance to the company in decision making • Easy to understand • Clarity	• Relevance – importance to the company in decision making • Easy to understand
Time – Can it be updated often to reflect the current state of the company?	• Support benchmarking and monitoring over time		
Unique to EPI criteria	• Be based on an overall evaluation of a company's operations	• Comprehensiveness	

Table 1: Qualities of Good Indicators

As Table 1 shows, the characteristics of good EPIs have significant overlap with the characteristics of good KPIs identified by SMART. This suggests that SMART is a valid evaluation method for EPIs as well. There is one notable difference though, the WBCSD and JME criteria add the requirement that the indicator be comprehensive such that it evaluates the company's operations as a whole.

Additionally, indicators have to be based on quality data to be trustworthy and valid representations of the impact they are measuring. The Data Management Association International (DAMA), a leading organization for data resource management professionals, developed a set of six core dimensions that are used to measure the quality of data. These are: completeness, uniqueness, timeliness, validity, accuracy, and consistency (DAMA UK Working Group, 2013). All these characteristics help in determining the value and usefulness of the data collected and are important criteria for determining the Accessibility of Data category in the SMART framework.

2.3.2 – Categories of Indicators

Indicators can be used to target different aspects of a company's operation. Rozner (2013) identifies five types of indicators: input, output, efficiency, process, and outcome. Process and outcome indicators focus on how particular outcomes are achieved, and less on the state of the quantity being measured. As a result, environmental indicators tend to be input, output, and efficiency type indicators. In an environmental context, input and output indicators measure the quantity of a resource that is consumed or produced, such as volume of water used, or units of product produced.

Efficiency indicators add normalization to input and output indicators, taking into account the scale of the company. For example, liters of water consumed per unit of product produced. Resource use and environmental impact can depend heavily on the scale of the company, so it is important for companies to normalize their environmental impact by some measure of scale (National Round Table on the Environment and the Economy, 2001). Normalizing indicators not only allows companies to measure progress as they grow, but also allows them to compare their progress to the progress of other companies. While one weakness of efficiency indicators is that they are hard to understand without context such as benchmarks and targets, they become useful for showing trends over time. As a result, companies can use efficiency indicators to compare current data to previous results, independent of how the company has changed over time.

2.3.3 – Roles of Environmental Performance Indicators

EPIs play an important role in various company functions. For example, EPIs improve the internal and external communication about the status, and changes to a company's environmental impact. Figure 1, adapted from Olsthoorn et al. (2001), summarizes the various roles EPIs play for various stakeholders.

Figure 1: Roles of EPIs for Stakeholders

Internally, EPIs play a crucial role in providing the information needed for managers to make intelligent decisions regarding the impact their companies have on the environment, as shown in the top of Figure 1. Hourneaux et al. (2014) also proposes that EPIs serve additional internal functions such as monitoring a specific environmental area in a company, identifying weaknesses in environmental management systems, distributing resources more efficiently, and creating a mechanism of accountability for environmental outcomes.

Externally, EPIs are used to report compliance with government regulations. For example, in Costa Rica, companies that use boilers and produce wastewater from production are required to submit a report on specific indicators every six months to the health ministry and Ministry of Environment and Energy (MINAE). Failure to do so can result in fines and possible shutdown of the company's operations.

2.3.4 – Existing EPI Frameworks

A variety of frameworks have been proposed for approaching the selection of EPIs for companies. We reviewed indicators from frameworks that are global in scope developed by four of the leading authorities in the field of environmental indicator reporting. Each framework varies in some degree as to what it proposes as the most useful indicators for conveying economic and environmental data and tracking trends. The following organizations produced the frameworks we analyzed:

1. The Global Reporting Initiative (GRI), is widely considered the "leading authority" within the discipline of sustainability reporting, with almost 6000 companies participating in 2015 (Dilling, 2010; GRI, 2016). A total of 30 different environmental indicators are outlined within the popular GRI framework.
2. The World Business Council for Sustainable Development (WBCSD), is a global organization comprised of over 200 member companies that represent some of the largest corporations globally. A total of 21 different indicators are considered by WBCSD to be

most effective for businesses to understand both their environmental impacts and the effects of these impacts on company value (Verfaillie & Bidwell, 2000).

3. The National Round Table on the Environment and the Economy (NRTEE) was a Canadian governmental agency that produced reports addressing issues of sustainable development from 1987 until 2013. A report produced by the NRTEE identifies 7 different "eco-efficiency" indicators (National Round Table on the Environment and the Economy, 2001).
4. The United Nations has also developed sets of indicators applicable to businesses in particular. A report produced by the United Nation Economic and Social Commission for Asia and the Pacific (UN ESCAP) details a total of 12 eco-efficiency indicators (Ichimura et al., 2009).

A total of 70 indicators were extracted from frameworks developed by the four organizations mentioned above. These 70 indicators are a mixture of input, output, and efficiency indicators. Each report provides information on the definition of the indicator, example units for expressing the indicator, and the environmental category the indicator belongs to. Additionally, the report identifies whether the indicator is generally applicable for all companies or whether it is specific to certain sectors. For example, Table 2 below shows the breakdown of the indicators from each framework by what environmental category an indicator addresses, and shows the emphasis on indicators related to emissions, energy, water, and waste.

	GRI	NRTEE	UN ESCAP	WBCSD	Total
Biodiversity	5				5
Compliance	1				1
Contamination	1			1	2
Emissions	5		4	7	16
Energy	5	3	2	1	11
Expenditures	1				1
Land			1		1
Materials	2		1	1	4
Overall	1				1
Packaging	1			1	2
Transport	1				1
Value				6	6
Waste	2	2	1	3	8
Water	5	2	3	1	11
Grand Total	30	7	12	21	70

Table 2: Comparison of the number of indicators proposed in various frameworks broken down by the issue the indicators address

The list of indicators and associated information obtained from the analysis of these frameworks was the basis for our on-site work in Costa Rica. The complete list of indicators and related information can be found in Appendix A.

2.3.5 – Barriers to Adopting the Use of Environmental Performance Indicators

While indicators have proven to be useful, companies still face difficulties surrounding the process of using indicators. According to Rosen et al. (2012) and Hák et al, (2012), the common challenges that companies face when adopting the use of environmental indicators are:

1. Selecting EPIs: As discussed in Section 3.4 and shown above in Table 3, there are a variety of frameworks that suggest possible indicators to measure environmental impact. This makes the process of selecting indicators complex and resource intensive as there is no existing unified set of indicators that companies can use.
2. Lack of resources to obtain the data needed: Using environmental indicators requires quantitative measurements; measuring equipment is a capital investment that some companies may not be willing to make.
3. Disclosure of negative practices: Environmental indicators track a company's progress on its environmental impact. Indicators may reveal environmental impacts or lack of progress toward meeting regulations or other environmental sustainability goals. Such information may expose the company to regulatory penalties and negative publicity, both negative impacts that companies would like to avoid

EPIs serve as a tool for companies to simplify environmental accounting. As a result, the barriers to adopting EPIs are largely similar to the barriers to using environmental accounting that we identified in Section 2.2.2.

2.4 – Summary

Negative environmental and social impacts of companies in Costa Rica are a major roadblock to achieving the country's sustainability goals. A globally recognized method of providing information on companies' negative environmental impacts and helping to develop strategies to mitigate them, is environmental accounting. To communicate the complex trends associated with environmental accounting more effectively, companies can use environmental indicators to summarize environmental performance. Despite the benefits of environmental accounting and environmental indicators, there are barriers to their use that have restricted their adoption by companies. While we know the barriers that companies have encountered in other countries across the world, the barriers to their use have not been studied in Costa Rica, a gap that our project was designed to fill.

Chapter 3: Methodology

The goal of this project was to assist CICR in promoting the use of environmental indicators in Costa Rican companies by better understanding the benefits, barriers, and best practices of their use. Four objectives guided our research:

Objective 1: To develop an understanding of environmental indicator use in Costa Rica from experts in the field

Objective 2: To determine companies' current environmental data collection practices

Objective 3: To determine how managers utilize and view the use of environmental indicators

Objective 4: To synthesize and effectively communicate our recommendations

The first three objectives in this four-objective process involved data collection and analysis. The fourth and final objective involved the synthesis of information obtained from the first three objectives, which informed our recommendations.

Our data gathering plan was directed at two populations, detailed in Table 3. The first population included experts in the field of corporate environmental responsibility. We gathered information from this population through interviews. The second population included the 830 member companies of CICR, plus all companies that attend CICR training workshops. We retrieved information from a sample of this population through both interviews and a survey on companies' environmental data collection practices.

Data Gathering Strategy				
Population	Method of Gathering Information	Sample	Relevant Objectives	Reason for Inclusion
Experts on Corporate Environmental Responsibility	Interviews	3 Representatives from CICR	Objective 1	Allowed us to draw on experts' experiences working with a breadth of companies
		1 Representative from AED		
		1 Representative from Aliarse		
830 Member Companies of CICR + All Companies That Attend CICR Training Workshops	Survey of Environmental Data Collection Practices	28 Costa Rican Companies	Objective 2	Allowed us to determine the environmental data that companies currently collect
	Interviews with Environmental Managers	7 Member Companies of CICR	Objective 2	Allowed us to determine how and why companies collect environmental data
	Interviews with Management Level Executives		Objective 3	Allowed us to determine how environmental indicators help companies make decisions

Table 3: Summary of Data Gathering Strategy

In summary, we sought input from these populations in order to be informed of the barriers, benefits, and best practices of companies using environmental indicators in Costa Rica. The following sections will explain in greater detail how we approached accomplishing our four objectives.

3.1 – Objective 1: Develop an understanding of environmental indicator use in Costa Rica from experts in the field

The purpose of this objective was to learn from experts in the field of corporate environmental responsibility about the current state of environmental indicator use in Costa Rica. Our intent was to learn about existing challenges that are associated with companies using indicators, and also what the most commonly used indicators in Costa Rica are. Because these experts have worked with a large number of companies, their perspective was an important addition to direct contact with the member companies of CICR.

We conducted a series of interviews with five environmental consultants representing three private organizations:

1. Cámara de Industrias de Costa Rica (CICR): Their mission is to represent the interests of the industrial sector of Costa Rica
2. Asociación Empresarial para el Desarrollo (AED): Their mission is to promote sustainable business models in Costa Rican companies
3. ALIARSE para el Desarrollo: Their mission is to promote public-private partnerships that contribute to sustainable development

A list of the specific environmental consultants that we interviewed, along with their respective organizations, can be found in Appendix C. During these interviews, we asked environmental consultants targeted questions about the most commonly used environmental indicators, as well as the benefits and barriers to using environmental indicators. The complete guide for our interviews with environmental consultants, including the questions that we asked, can be found in Appendix D.

3.2 – Objective 2: Determine companies' current environmental data collection practices

The purpose of this objective was to determine what environmental data companies currently collect, how they do so, and their perspective on collecting additional data. This objective was accomplished through both interviews and surveys of environmental managers (or equivalent) of Costa Rican companies.

The survey that we distributed to company representatives inquired about whether or not their respective company collects the environmental data required for certain indicators. The indicators that we used to create these questions were based upon our literature review. Our literature review identified a list of 70 indicators collected from four separate frameworks, shown in Appendix A. However, this initial list contained some redundancy, and as a result we eliminated indicators that are used to report similar information. This process narrowed down

the list to 45 distinct indicators, shown in Appendix B. Our survey questions were created to ask company representatives whether or not their company collects the necessary data to use indicators from this list of 45. These questions were grouped based upon environmental category (e.g. water, waste, energy, etc.). Additionally, we included questions about company size and industry, in order to be able to draw conclusions from the data we received. The survey was distributed to all 830 member companies of CICR, and 16 additional companies that attended a wastewater training session at CICR. The survey questions can be found in Appendix E.

In addition to the survey, we interviewed environmental managers (or equivalent) of seven member companies of CICR. These seven companies were chosen because they had previously worked with CICR on environmental projects. As a result, these companies were expected to provide us with examples of indicator use. The interviewed companies represented six industries and a range of sizes. For confidentiality reasons these companies cannot be identified, however a list of their industries and sizes can be found in Appendix F. The guide for our interviews with environmental managers (or equivalent), including the questions that we asked, can be found in Appendix G.

The interviews ultimately allowed us to gain more insight into what data each company collects, how data are collected, and barriers associated with the process. Additionally, the environmental managers (or equivalent) had access to the survey questions prior to our interviews. As a result, the survey and interview data complemented each other.

3.3 – Objective 3: Determine how managers utilize and view the use of environmental indicators

The purpose of this objective was to determine the perspective of management level executives on the usefulness of environmental indicators in making decisions. To accomplish this objective, we conducted interviews with a manager from the same seven companies that we contacted for Objective 2 (Appendix F).

During our interviews with managers, we asked targeted questions about why they chose to use certain indicators, and the purposes that those indicators serve to the company. Additionally, as discussed in Section 2.3.2 of our literature review, indicators can be more useful for business decisions when they are normalized by some measure of the company's output. Accordingly, we asked the managers about their perspective on normalizing indicators. Also, Section 2.3.5 of our literature review identifies common barriers to the use of indicators to be a lack of attainable data, financial constraints, and time constraints. In response, we asked managers what barriers they believed inhibited the use of indicators. The guide for our interviews with managers, including the questions that we asked, can be found in Appendix H.

3.4 – Objective 4: Synthesize and effectively communicate our recommendations

The purpose of this objective was to synthesize the information gathered from the previous three objectives, and to develop appropriate recommendations for CICR in order to assist Costa Rican companies.

Because interview responses are a form of qualitative data, we interpreted them through a systematic method of coding. Coding is the process of assigning a word or phrase to symbolically represent the essence of a longer piece of text (Saldana, 2009). Through coding, we simplified the interviewees' answers by identifying the general ideas presented. Two team members were responsible for coding each interview response independently. We did this in order to minimize potential bias. If there were any discrepancies in codes, a third team member would code the same interview response.

Once coding was complete, we created a chart to organize our information. This chart compared the interview responses to each question, and also showed the source of each response. By organizing the information in this way, we were able to determine the frequency of each idea being mentioned, and were able to collect especially powerful quotes that served in informing our results and recommendations.

Chapter 4: Results

In this chapter we present the results of our research, organized into seven findings. First, we discuss the benefits and barriers to using environmental indicators. Next, we discuss the specific indicators that our sources believed to be the most useful for companies in Costa Rica. Then, we discuss our observations on how Costa Rican companies normalize data, the existing discrepancies in the importance of carbon footprint measuring, and the low reporting for CICR's Premio Excelencia award program. Lastly, we discuss limitations to our findings.

These findings were the result of data gathered from our interviews and survey. The interviews were conducted with company representatives from seven companies (Appendix F) and with experts in the environmental area (Appendix C). For our survey, 28 companies responded, split between SMEs (13 companies) and large companies (15 companies). These companies represented eight industries, with a majority (17 companies) in the manufacturing sector.

4.1 – Finding 1: Companies benefit in three ways from the use of environmental indicators

Three benefits were consistently mentioned by company representatives and environmental consultants. These benefits were largely a reaffirmation of Section 2.3.3 of our background research.

4.1.1 – Compliance with governmental regulations is enabled by the use of indicators

Compliance is considered a fundamentally important use of indicators because non-compliance can lead to penalties. According to a representative from a coffee processing plant, "if you don't comply, they [the government] are going to close your factory immediately." The importance of using indicators to demonstrate compliance was echoed by four other companies and three of the five consultants that we interviewed.

According to our interviewees, different indicators are needed for compliance depending on economic sector and type of business operation. For example:

- Companies that handle food products are subject to regulations from both the Costa Rican government, as well as the governments of some countries that they export to. Regulations regarding nutritional content, processing of food products, and sterilization information are some of the quality indicators that companies are required to report (Company F, personal communication, February 8, 2017; Company D, personal communication, February 10, 2017).
- Companies that use boilers, common in the manufacturing sector, must send a report on their air emissions to the Ministry of the Environment and Energy (MINAE) every six months. Indicators of the quality of air emissions that must be reported include CO2 content, SO2 content, NOx content, and particulate concentration measured in parts per

million (A. Carvajal, personal communication, January 30, 2017; N. Gamboa, personal communication, February 13, 2017; Company G, personal communication, February 15, 2017).

- Companies that produce wastewater as the result of their processes must report to MINAE twice per year the qualities of the wastewater. Indicators of wastewater quality that must be reported include pH, temperature, fats, and biological/chemical oxygen demand. In order for a company's wastewater to be legally discharged into the environment, these indicators must fall within certain ranges (A. Carvajal, personal communication, January 30, 2017; Company F, personal communication, February 8, 2017; N. Gamboa, personal communication, February 13, 2017; Company G, personal communication, February 15, 2017). Additionally, according to a representative from a cleaning chemical manufacturing company, companies that use well water are subject to use restrictions from the government (Company A, personal communication, February 9, 2017).

4.1.2 – Internal company efficiency can be improved through indicators

The second benefit to using indicators, consistently mentioned in our interviews, is to improve company operations. According to an interviewed environmental consultant, companies can use indicators to increase internal synergy amongst the different branches of their operations. Being able to monitor company operations and track the allocation of resources via indicators allows company managers to make decisions and employees to design more efficient processes. This allows companies to "control their processes," according to Agustín Rodríguez Carvajal of CICR.

Three of the seven companies that we interviewed currently use indicators in order to monitor specific processes of company production. While indicators are most commonly used to measure company-wide progress, three companies demonstrated that using indicators for specific processes can help to better identify areas of inefficiency. For example, a representative from a cleaning chemical manufacturing company shared that their company makes use of eight separate flow meters throughout their production facility. These flow meters allow the company to monitor water usage for each part of the building and also for each individual process of production (Company A, personal communication, February 9, 2017). Similarly, a representative from a food production company said that they "monitor how much water is used in cleanup." This information helps identify any areas of unnecessary waste for the company (Company F, personal communication, February 8, 2017). When asked about the benefits of using indicators, every company that we interviewed identified that indicators are useful for identifying areas of inefficiency.

Once companies have a greater understanding of their processes they can attempt to reduce their resource usage and environmental impact through targeted projects, and ultimately save money. According to representatives from two companies that we contacted, carefully monitoring energy usage through the use of indicators is instrumental in calculating the cost savings of renewable energy projects, such as wind turbines or solar panels (Company A, personal communication, February 9, 2017; Company G, personal communication, February 15, 2017).

4.1.3 – Marketability can be improved by the use of indicators

According to two of the seven companies that we spoke with, an additional benefit associated with the use of indicators is increased company marketability. Companies are able to use information regarding their environmental impact to market themselves to green consumers and clients. Certifications are one way that companies are able to convey this information. For certain products, companies can become less competitive if they fail to invest in environmental certifications. An executive manager from a coffee processing company shared with us the benefits of their Rainforest Alliance certification: "One of the major and the main clients that we have, they buy Rainforest Alliance certified coffee and just that" (Company D, personal communication, February 10, 2017). Similarly, a representative from a cleaning chemical manufacturing company said that their environmental certifications are important when selling to other environmentally certified companies (Company A, personal communication, February 9, 2017). Indicators are important for companies that are considering applying for certifications, because they provide information necessary to receive the certifications.

While indicators can assist with acquiring certifications and increasing marketability, the level of benefit depends on the individual company's business model and target consumers. Only two of the seven companies we investigated use indicators in their marketing strategy, while one company said that they had found that environmental certifications were not important to their customer base (Company F, personal communication, February 8, 2017).

4.2 – Finding 2: Five barriers impede the use of indicators for companies

We identified five commonly mentioned barriers that prevent companies from utilizing environmental indicators and reaping the aforementioned benefits. These barriers are:

1. A lack of motivation for companies to implement environmental indicators
2. Poor internal communication about environmental issues
3. Inadequate employee knowledge
4. Limited resources to use indicators
5. Insufficient infrastructure to acquire the necessary data for indicator usage

These barriers were identified by learning about companies' current environmental collection practices, and through interviews with experts in the field. Additionally, we go on to discuss how these barriers present themselves differently for SMEs and large enterprises.

4.2.1 – A Lack of Motivation for Companies to Use Environmental Indicators

The primary barrier that companies must overcome to use environmental indicators is inadequate motivation. Sergio Arias described it as "a lack of vision," and all of the environmental consultants that we interviewed expressed a similar sentiment. We found two reasons for this lack of motivation.

First, there may be little or no perceived financial benefit from the use of indicators. Environmental consultants suggested that within companies that do not use environmental indicators, the investment required for data collection outweighs perceived benefits (S. Arias, personal communication, January 30, 2017). Environmental consultant Pablo Rojas stated that "if the company can find a way to profit or differentiate themselves because they are measuring, reducing, and compensating, they will definitely." For example, municipal waste disposal in Costa Rica is billed at a flat rate. Thus, companies have little financial motivation to reduce their waste production, unless they produce enough waste to require a waste disposal service (P. Rojas, personal communication, February 2, 2017). However, water and electricity are notable exceptions, as 81% of the companies who responded to our survey collect both types of data. These data are easy to collect for the company as a whole, as companies are billed for these services based on the amount used. However, measuring the use of these services at a finer level of detail, which is more useful for decision making, requires an investment of company resources (Company E, personal communication, February 9, 2017).

Secondly, regulatory bodies and consumers are not demanding reports of environmental data. Most certifications require only specific types of data, and often do not cover the full spectrum of environmental categories (Company F, personal communication, February 8, 2017). Multiple companies indicated that they only acquired certifications when it was demanded by consumers in order for them to remain competitive in the marketplace (Company D, personal communication, February 10, 2017). Additionally, there are currently no governmental incentive programs to encourage companies to adopt indicators (A. Carvajal, personal communication, January 30, 2017).

4.2.2 – Poor Internal Communication About Environmental Issues

All of the environmental consultants that we interviewed agreed that most larger companies have dedicated environmental managers or individuals responsible for environmental data. However, these environmental consultants questioned the ability of large companies to distribute data to all people who need it. Pablo Rojas stated "There is this assumption that you can assign someone and tell him 'you are in charge of everything regarding the environment' and then when that person begins to look and to have all those indicators, obviously not every indicator depends on him. He has to go to other people, and those other people might not know the importance of that number as much as the environmental person." The communication barrier was reflected in our survey, as well. Four of the 28 companies who participated in our survey (two SMEs and two large companies) had two different employees respond to the survey. None of these response pairs matched, showing that these companies may not be communicating effectively about environmental issues.

4.2.3 – Inadequate Employee Knowledge

Both SMEs and large companies can be affected by a general lack of knowledge amongst employees concerning environmental sustainability (N. Gamboa, personal communication, February 13, 2017). Operations are improved when all levels of employees throughout the company understand the key role indicators can play in a company's success (Company F, personal communication, February 8, 2017). From the production worker who is responsible for utilizing the resources being measured to the top-level manager making decisions based on the

indicators, an understanding of the purpose of the data and indicators is key to the success of indicator-based decisions (P. Rojas, personal communication, February 2, 2017). SMEs may be particularly affected by the knowledge barrier, as they often do not have dedicated environmental managers who are educated about environmental issues (A. Carvajal, personal communication, January 30, 2017). This is problematic for a number of reasons but mostly because there is not always a knowledgeable employee who can make sense of environmental data and look for areas of improvement. While communicating about environmental issues may be easier within SMEs, without an employee that is knowledgeable about how to use that information to make informed decisions the benefit is lost.

4.2.4 – Limited resources for Using Environmental Indicators

Limited resources refers to both human and financial resources, and applies more to smaller companies than it does to large enterprises. Larger companies are more likely to have the financial resources and employees to dedicate to environmental projects. A manager from a large company we interviewed indicated that the company sometimes struggles with distributing these resources appropriately, but distribution of these resources is related to the communication barrier, and not a lack of resources.

An expert we interviewed argued that small companies generally do not have the financial resources to hire a dedicated environmental manager to manage the collection, organization, and utilization of environmental data. Without an environmental manager, the human resources for the collection of data, and the calculation of indicators must be drawn from the existing pool of employees. For SMEs, the additional resource load can be a significant issue.

Investing in equipment to measure the use of resources such as electricity and water at a process level is an additional barrier for companies without the available financial resources. To understand the full breakdown of resources used across the company, each resource should be monitored everywhere it is used (Company F, personal communication, February 8, 2017). For example, flow meters should be installed everywhere water is used, and every major device that uses electricity should have a meter attached. Recording all of these measurements regularly adds an additional human resource burden, even for companies with an environmental manager (Company B, personal communication, February 15, 2017).

4.2.5 – Insufficient Infrastructure to Acquire Necessary Data

Not only is measuring equipment expensive, but retrofitting this equipment into an existing facility is also costly, and at times is simply not feasible given physical constraints related to the design of facilities (S. Arias, personal communication, January 30, 2017). As a result, many companies rely on low frequency (monthly, semi-annually or even yearly) manual measurements, making the data less valuable for continuous process improvement (Company E, personal communication, February 9, 2017). Building automated data collection infrastructure was a solution for one large company we interviewed, but a system of this scale and complexity is most applicable to companies with a high volume of data (Company F, personal communication, February 8, 2017).

4.3 – Finding 3: There are differences in barriers between SMEs and large enterprises

Our evidence suggests that SMEs and large businesses face the five barriers differently. Figure 2 shows how the barriers we discussed in Section 4.2 typically apply to companies of different sizes.

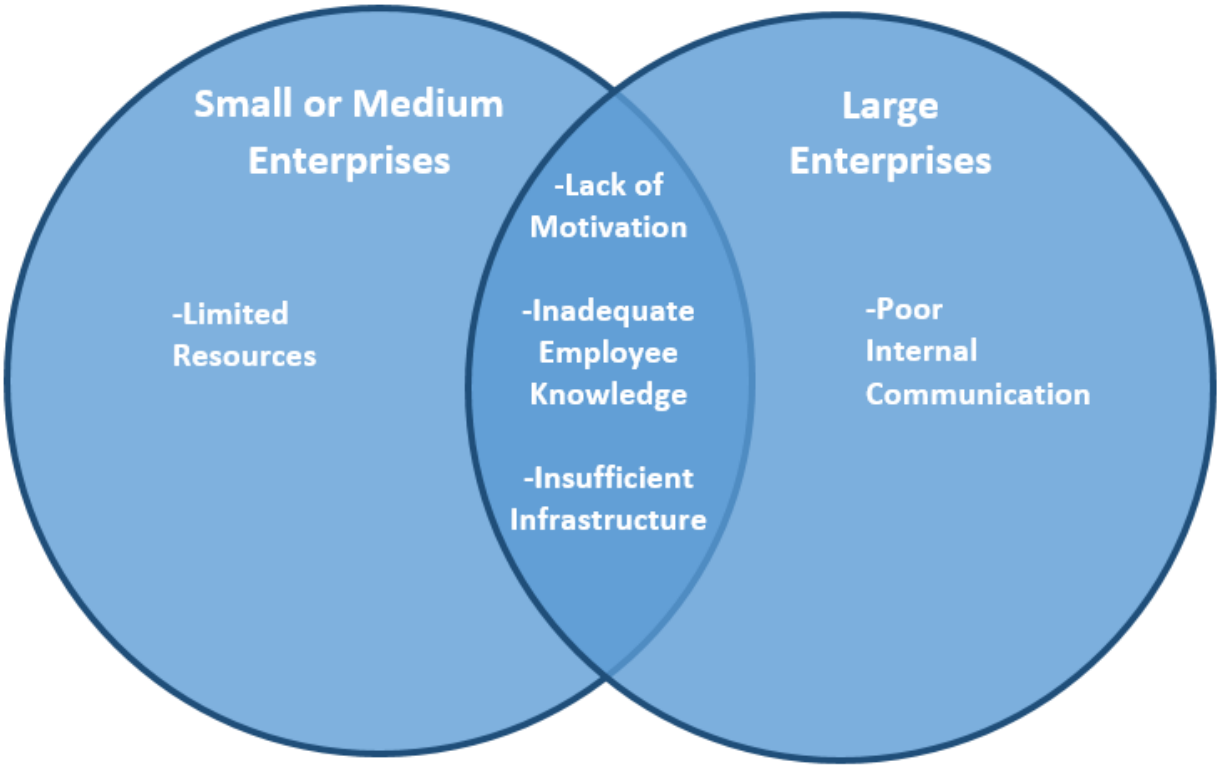

Figure 2: Barriers to Using Environmental Indicators for Different Size Companies

While a company of any size can be affected by any of these barriers, our interviews with consultants and companies revealed that the resource barrier affects SMEs most severely, and the communication barrier has the most significant impact on large companies.

While the barriers to the use of indicators are different for SMEs and large companies, our survey did not indicate that it affects their data collection practices. Large companies collected data on emissions and incentives more commonly than SMEs, but the difference was only marginally significant. There was no significant difference between SMEs and large companies for the other 11 environmental categories on our survey. [1]

[1] These differences refer to the questions that asked companies if they collect any data related to an environmental category, not the number of types of data within each category, or how often they collect those data.

4.4 – Finding 4: There are four indicator categories that companies and experts identified as most important

While some companies are more committed to reducing their environmental impact than others, all companies prioritize reducing expenses (S. Arias, personal communication, January 30, 2017; P. Rojas, personal communication, February 2, 2017). Consumption of electricity, water, and fuel, as well as the disposal of waste, are costs that affect a broad range of companies in Costa Rica. Each of the four categories have varying significance to every company. However, every company that we talked to, as well as the environmental consultants, identified one or more of these indicator categories as an important consideration for their business. Of the companies that responded to our survey, 57.1% collected data on all four categories, and 75.0% collected data on at least electricity, water, and waste. It is also interesting to note that these four categories are also emphasized in the indicator frameworks identified in our background research, representing 30 of the 70 indicators from the four frameworks. The benefits (as described in Section 4.1) and the barriers (as described in Section 4.2) to using these indicators are detailed for each indicator category in Table 4 below, and followed by a more in-depth description and examples of specific indicators in the following section.

Category	Benefits	Barriers
Energy	Internal Efficiency, Marketing (carbon neutrality)	Limited Resources, Insufficient Infrastructure
Water	Compliance (wastewater), Internal Efficiency	Limited Resources, Insufficient Infrastructure
Waste	Compliance, Internal Efficiency, Marketing (carbon neutrality)	Lack of Motivation, Limited Resources
Fuel	Internal Efficiency, Marketing (carbon neutrality)	Poor Communication, Inadequate Employee Knowledge, Limited Resources

Table 4: Key Indicator Categories and Benefits

4.4.1 – Energy

Companies and environmental consultants alike identified electricity as the most common and useful form of energy measurement (A. Carvajal, personal communication, January 30, 2017; P. Rojas, personal communication, February 2, 2017). Paying for electricity represents an immediate, direct cost for companies. As a result, companies generally have motivation to record information about electricity in order to become more efficient and consequently save money. This presumption is supported by the results of our survey, as 88.5% of companies that responded to our survey measure energy consumption. Electricity is most commonly recorded in kilowatt hours (kWh), which provides companies with a measurement of total energy consumed.

However, there is a major barrier to using electricity indicators. The meters used to measure electricity are expensive and require a significant investment when used to measure

specific processes of company production (A, Carvajal, January 30, 2017). If companies are not willing or able to make this investment for measuring equipment at the process level, electricity indicators are less useful for improving internal efficiency. Reluctance to make this investment highlights the resource and infrastructure barriers to the efficiency benefit.

4.4.2 – Water

Companies and environmental consultants identified indicators of fresh-water consumption and wastewater production to be equally as important and useful as indicators of energy use for companies in Costa Rica. Similar to electricity, companies that use water have to pay for it, so data are easily available, tracked carefully, and presents a financial incentive for companies (P. Rojas, personal communication, February 2, 2017). Of the companies responding to our survey, 96.2% collected water data. There are several sources of water that companies commonly use, and some companies use more than one.

A key role of water-related indicators is monitoring wastewater quality for compliance. Several different indicators could be used depending on the necessary treatment of the company's wastewater. Some examples of these include temperature, pH of wastewater, biological/chemical oxygen demand, and suspended solid content (A. Carvajal, personal communication, January 30, 2017; Company F, personal communication, February 8, 2017).

Municipal water (used by 61.5% of the companies participating in our survey) use can be tracked through the company provider, which is a simple and quick process (P. Rojas, personal communication, February 2, 2017). Monitoring water usage from municipal sources represents a significant opportunity for cost savings for companies. For process level measurements, hydrometers need to be installed at the point of use (Company A, personal communication, February 9, 2017). However, in some cases installing these hydrometers can be difficult or even impossible because existing water distribution systems often cannot be altered, or installation is cost-prohibitive (Company F, personal communication, February 8, 2017). Similar to the electricity indicators, the resource and infrastructure barriers impede companies from realizing the internal efficiency benefits.

The second most common source of water in Costa Rica is well water (38.5% of companies participating in our survey). Companies have to strictly monitor the amount of water that they are extracting from wells to ensure compliance with regulations (Company A, personal communication, February 9, 2017). Additionally, many companies have to treat their well water before they use it, so monitoring and minimizing water use presents an opportunity to reduce water treatment costs (S. Arias, personal communication, January 30, 2017).

Rainwater is the third, and least common source of water that companies use (11.5% of surveyed companies). Rainwater is typically used for cleaning or other processes in which water quality is not of primary concern (Company C, personal communication, February 16, 2017). Tracking rain water is useful because companies can monitor how much water they are saving from other sources, which in turn helps companies determine their cost savings (Company A, personal communication, February 9, 2017).

4.4.3 – Fuel

Fuel indicators cover all types of fuel, broken down by type and reason for use. Recording detailed information about the amount of each type of fuel used allows companies to carefully monitor areas where money could be saved (Company F, personal communication, February 8, 2017). For companies that have the ambition of being carbon neutral, tracking the amount of fuel used throughout all processes is necessary.

There are, however, difficulties in obtaining data for fuel usage indicators. For example, recording the amount of fuel used in company cars for transportation can be logistically challenging for many companies. Only 65% of the companies that responded to our survey indicated that they collect data related to fuel use for transportation. An example of how to overcome this issue is offered by Company A, a carbon neutral company. Company A is able to track the fuel used in company cars by having a direct partnership with a local gas station. Company A only allows its company cars to be filled at this specific gas station, and in return this gas station reports all quantities of gas purchased back to Company A for calculation (Company A, personal communication, February 9, 2017). The benefit of having such detailed information is that the company is then able to identify areas of inefficiency (Company A, personal communication, February 9, 2017). A representative from an SME that we contacted said that they schedule deliveries in the early morning to avoid traffic, and choose their delivery routes to avoid congested areas. This allowed them to see improvement in their transportation fuel usage indicator. Similarly, Company F has an on-site LPG refueling station for their forklifts, which gives them easy access to fuel consumption data for their forklift fleet (Company F, personal communication, February 8, 2017).

4.4.4 – Waste

Waste indicators are more important for companies who produce high volumes or special types of waste, but 84.6% of companies we surveyed collected data on waste in some way. We identified waste as a generally useful indicator category because of the significant environmental impact associated with waste, and also because of potential cost savings for some companies. The most general indicators are total mass of waste produced and the mass of waste recycled. For compliance, the quantity of hazardous and special waste generated are important as well.

Companies who produce small volumes of waste can dispose of their waste through flat-rate municipal services (P. Rojas, February 2, 2017). The flat rate, regardless of the actual volume of waste generated, means that there is little incentive for companies with low waste volumes to use a waste indicator.

However, companies who produce large volumes of waste have to pay for disposal based on the amount and type of waste produced (P. Rojas, February 2, 2017). For these companies, using an indicator to measure waste can help achieve significant cost savings (Company C, personal communication, February 16, 2017). This direct cost means that there is an incentive for companies to track and reduce their waste production, and that monitoring waste production by type can show companies the most effective targets for improvement.

Companies that produce hazardous waste are required by the Costa Rican government to report information about the quantity and type of waste produced. As a result, using indicators

for hazardous waste in this situation is necessary for compliance (A. Carvajal, personal communication, January 30, 2017).

4.5 – Finding 5: Normalization of indicators is important for companies

Four of the seven managers that we interviewed said that their company normalized the indicators they use by some measure of the output of their company. All four companies used the mass of their product as their normalization factor, but one food production company is also considering normalizing by the revenue of each of their different product offerings. Using revenue would allow them to take into account the different ratio of resource usage for each type of product, and allow them to compare the products to each other.

Normalization was a concept identified in our background research (Section 2.3.2) as a way for companies to compare their indicators over time, independent of the scale of a company's operation. This was particularly important for the two food companies that used normalization, as their operations are highly seasonal, and comparing high-season consumption to low-season consumption would be meaningless.

4.6 – Finding 6: There is a disconnect between companies and environmental consultants on the importance of measuring carbon footprint

All the interviews conducted with company representatives and environmental experts recognized that the four indicator categories discussed in Section 4.3 were important to company operations. Measuring carbon footprint, a vital step toward the country's goal of carbon neutrality, was mentioned by all five environmental experts. However, only three of the seven companies we interviewed viewed measures of carbon footprint as an important indicator. Two of those companies are certified as carbon neutral, and the third is working toward achieving this certification. According to a company representative that we interviewed, currently only 63 companies in Costa Rica are carbon neutral (Company C, personal communication, February 16, 2017). Just 39.3% of companies responding to our survey measured CO2 emissions, and only 25.0% measured total air emissions. While measuring carbon footprint relies on other indicators as well, the lack of direct emissions data show that carbon footprint is a low priority for companies.

When we interviewed companies that are certified as carbon neutral on why they chose to become carbon neutral, they mentioned two benefits. First, the certification helps them have a competitive advantage in the market by standing out from their competitors. Second, the certification provides a standard method of comparing their processes and progress with other companies (Company C, personal communication, February 16, 2017; Company D, personal communication, February 10, 2017). Companies use indicators that they believe will benefit them, and not all companies see benefits associated with measuring carbon emissions. A similar idea was echoed by Pablo Rojas, who told us that, "the typical businessman will say obviously there is a direct link between energy and water impact directly to my company. And emissions,

not so much, then it is my job to tell him that emissions are important too." This lack of understanding by companies leads to a disconnect between the country's goal and the practices of companies within Costa Rica.

4.7 – Finding 7: There is a disconnect between the number of companies reporting indicators for the Premio Excelencia and the number of companies collecting data

Only five out of CICR's 830 member companies submitted environmental indicator data for the environmental section of CICR's corporate awards program, the Premio Excelencia. In contrast, our survey results show that companies collect the information required for the five required indicators in the Premio Excelencia report. Of the 16 CICR member companies that responded to our survey, 15 collect data for at least one of the indicators. So, while 0.6% of companies are reporting data, our survey indicates that 93.8% of companies are collecting at least some of the appropriate data. Four of the companies (25%) collected all of the indicators, but data for all five indicators is not required to submit for the award, so that is not a barrier for the other 75% of companies. There was no significant difference between SMEs and large companies, indicating that the difference in reporting is not a result of CICR's membership composition, which is over 80% SMEs.

One possible reason that companies do not participate in the environmental section of the Premio Excelencia is a reluctance to share environmental impact information with other companies. Sergio Arias, director of the Premio Excelencia program, said that "the companies are jealous about information...or they don't want to share it with other companies."

4.8 – Limitations of Our Results

While our intended methodology attempted to address possible shortcomings of our research, three limitations remained: the samples our research was based on, the self-reported data that we obtained from our interviews, and fewer data sources than we expected.

First, our interview sample was not random and was also small. We interviewed a total of seven companies that were selected by CICR because they had previously worked on environmental projects. The companies were not selected based on random sampling and should not be considered a reflective representation of all companies in Costa Rica. We attempted to learn from these companies examples of best practices, and we aimed to provide more thorough recommendations to companies that are not as successful as those that were interviewed. Additionally, the small sample size made it difficult for us to establish significant relationships among the companies as almost all of them operate in different sectors. Thus, it was difficult to draw meaningful conclusions on general environmental practices of the different sectors in Costa Rica.

Our survey responses had similar issues to our interviews. The small sample size might have contributed to the lack of significant differences between large and small companies in their data collection practices. Five of the responding companies were companies that we interviewed, and as previously discussed, the interviewed companies have previously shown an interest in

environmental projects. The remainder of our responses were from paper surveys distributed at a wastewater training seminar at CICR. These companies have enough interest in environmental projects to attend a training seminar, and we expect that this also means that they are more likely to collect environmental data in general.

Second, our findings were based on self-reported data that we obtained through interviews and surveys. Self-reported data cannot be independently verified and can be biased (USC, 2017). For example, all of the companies that were interviewed informed us of their environmental projects, and none of them disclosed any negative practices.

Third, we were not able to collect data from certain sources that we expected to. We had planned on sending our initial indicator list of 70 indicators to the Environmental and Social Responsibility commission (ESR) of CICR in order to get feedback on what indicators were the most relevant and applicable to Costa Rican companies. Due to personal reasons, the head of ESR was not able to get back to us. Also, the survey that was sent to the member companies of CICR through the environmental bulletin yielded 0 responses. As a result, our findings do not reflect any data from those two sources.

Despite these limitations, our empirical results are generally consistent with our literature review. Additionally, all of the findings from our empirical research were corroborated with information from multiple sources. Unexpected sources of information that proved useful were the environmental consultants, which gave us a more general overview of indicators in Costa Rica, based on experience with a variety of companies. The experts provided important perspectives on the barriers, as most of the companies that participated in our interviews had already used indicators successfully.

Chapter 5: Recommendations

We propose five recommendations based upon a synthesis of our empirical results and literature review. These recommendations suggest ways to overcome barriers to using environmental indicators and are intended to help companies reap the associated benefits of using environmental indicators. These recommendations are targeted at CICR, and detail specific actions CICR can take to help its member companies take full advantage of environmental indicators.

5.1 – Recommendation 1: CICR should classify their member companies by level of environmental performance

We recommend that CICR implement a four tiered system to classify their member companies with respect to environmental performance. These four levels are:

1. Bronze: Companies that don't collect environmental data
2. Silver: Companies that collect environmental data to demonstrate governmental compliance
3. Gold: Companies that use environmental data to improve operational performance and reduce environmental impact
4. Platinum: Gold level companies that CICR considers exceptional in their environmental performance, such as previous winners of the Premio Excelencia environmental category, and who can serve as role models for other companies

We recommend that CICR only use this categorization for internal purposes. While top-tier companies may see it as a reward, we see it as potentially discouraging to companies in lower tiers. A visual representation of this multi-tiered system can be found in Figure 3.

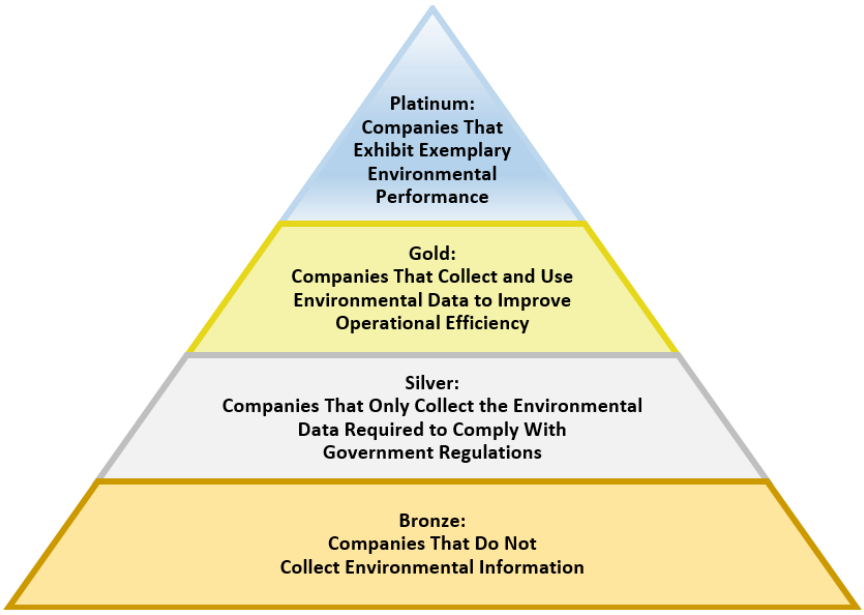

Figure 3: Proposed Four Environmental Tiers of CICR's Member Companies

By organizing companies with this system CICR will be able to target appropriate resources, such as training sessions and informational bulletins, at each level and support companies to initiate and improve environmental programs. Additionally, we recommend that CICR should place a greater emphasis on assisting the bottom-tier companies that are lagging behind. While it is important for the top-tier companies to continue to improve and excel, we recommend that CICR direct resources towards assisting bottom tier companies.

From our research experience, individual environmental consultants have connections with companies that represent the entire spectrum of this tier system. Combining their information and contacts to rank the associated companies based on their experiences will give CICR a basis for this system.

5.2 – Recommendation 2: CICR should provide training to member companies to facilitate the process of using environmental indicators

Our findings indicated that all companies, regardless of size, suffer from a lack of educational resources regarding the use environmental indicators. To address these barriers, we recommend that CICR develop training sessions to target each level identified in Recommendation 1. Some examples of these sessions for each level could include:

1. For bronze level companies, the sessions would be focused on the four main indicator categories, of electricity, water, fuel, and waste (see Section 4.4).
2. For silver level companies, training sessions would highlight the use of indicators to increase operational efficiency, and how to acquire data at a more specific process level. This was identified as a most useful practice in Finding 1 of our results.
3. For gold level companies, training sessions would be to educate companies about what certifications are available and applicable for their businesses. Most environmental certifications require companies to document their environmental impact and the steps that they have taken to reduce it. Environmental indicators are often used as the metrics by which certifications can assess such progress
4. For platinum level companies, CICR should work with these companies individually to develop environmental projects specific to each company.

All of these trainings could educate companies about the SMART method of evaluating indicators, which is identified in our literature review. It would be helpful for companies to decide for themselves the most applicable indicators for their own use.

5.3 – Recommendation 3: CICR should develop and disseminate straightforward, easy to use resources to its member companies that encourages the adoption of environmental indicators

We recommend that CICR provide their member companies with additional user-friendly resources to help them improve their use of environmental indicators. While CICR has

collaborated with multiple partners to produce documents and guides, such as the "Guía Cambio Climático y Adaptación del Modelo de Negocio" and the "Guía para diseñar un manual que permita a las PYMES realiza Declaraciones de carbono neutralidad bajo la norma INTE" for their member companies, additional resources that are less difficult to use and understand would be beneficial. Creating additional user-friendly resources would allow companies with limited financial, educational, and human resources to begin calculating environmental indicators. In this section we discuss two potential workbook-style resources we are proposing that CICR make available to their member companies.

The first resource that we propose CICR should provide to their member companies is a generic environmental indicator workbook. We have made and provided CICR with this resource as a deliverable. This workbook would be most useful to companies in the bronze or silver levels (defined in Section 5.1), as it would help introduce them to the process of using indicators. The workbook should contain an Excel spreadsheet to assist companies in tracking, recording, and calculating environmental indicators properly. The spreadsheet should assist companies in calculating the most commonly used environmental indicators that we identified in Section 4.4. Also, as identified in our literature review, using proper units for environmental data, and normalizing this data by a company output, are both important. As a result, environmental data for the indicators should be collected and recorded in the proper units (e.g. m3 of water, kWh of electricity, tons of waste produced). Since we found that it is common for SMEs to record their environmental data in monetary units, using proper units would be an improvement over current practices. This would require little extra effort on the company's part, as we found these data are accessible on monthly invoices, such as electrical and municipal water consumption invoices. Additionally, the workbook would ask for some quantity of a company's output (e.g. units produced, mass of product produced, or number of employees) and use this information to normalize the given indicators. This workbook would have integrated charts for companies to visualize the evolution of their performance over time.

We also recommend that the Excel spreadsheet be accompanied by a written document describing the context of the workbook. The document should include a short section that describes the benefits and uses of environmental indicators. Additionally, it should explain that the listed indicators are generally applicable, and more indicators exist that might be useful depending on the specific company. References should be included so that companies could investigate other indicators on their own, but efforts should be taken to maintain the brevity of the document. This document would also include a description of the SMART framework for evaluating indicators, as identified in Section 2.3.1 of our literature review. This would better enable companies to evaluate and identify indicators that are the most useful for them individually. If more generally applicable indicators are identified in the future, they should be added to the workbook accordingly. However, this as a long-term project.

The second resource that we propose CICR should provide to their member companies is a "carbon footprint calculator." As shown in Section 4.6 of our results, environmental experts have identified carbon footprint as an important indicator to track. However, not all companies that we interviewed expressed the same sentiment. Several groups, including governmental organizations such as the United States Environmental Protection Agency, NGO's such as the Carbon Trust Organization, and consultings groups such as Carbonfootrprint360, have developed generally applicable carbon footprint calculators. These models could serve as examples for CICR to develop their own more specific calculator tool. We propose that this carbon footprint

calculator would be composed of a spreadsheet with emission factors, specific to Costa Rica, from the Instituto Meteorológico Nacional (IMN). Companies could then use this to calculate their carbon footprint, which environmental experts considered an indicator of significant importance. In this spreadsheet, companies could input environmental data they likely already have available, such as electricity consumption or generation of wastes. The spreadsheet should calculate, record, and document the company's carbon footprint for the given time period. It should also have integrated charts that would show carbon footprint over time (i.e. weekly, monthly, etc.), as well as what sources generate the largest portion of the company's carbon footprint. The workbook would have to be updated annually by CICR, as the emission factors vary from year to year based on research by IMN. We suggest that updating the information contained within this spreadsheet, and disseminating the workbook annually, be the responsibility of the environmental consulting department at CICR.

While less comprehensive than some other documents available from CICR, these options are intended to provide companies with simplified resources. As our findings show, a barrier to using environmental indicators is that companies lack necessary education and understanding on how to use environmental indicators. We believe simplifying can help convince and motivate companies, particularly SMEs with limited resources, to start adopting the use of indicators. Overall, we believe these workbooks will encourage companies to adopt environmental indicators by alleviating educational, human, and financial resource barriers generally associated with their use.

5.4 – Recommendation 4: CICR should support the development of government programs that encourage the use of environmental indicators

We recommend that CICR lobby the Costa Rican government to create incentive programs that reward companies for positive environmental performance. If incentive programs were created, companies would adopt the use of environmental indicators to track performance and show improvements. Multiple companies we talked to reported that there is no incentive from the government to use environmental indicators other than those required for compliance, as discussed in Section 4.2.1. Without external incentives, the motivation to utilize environmental indicators must come from within the company, a barrier also discussed in Section 4.2.1.

There are already some programs under development in this area. For example, a new water law that we reviewed and that is currently under discussion is intended to reduce a company's water tariff if the company shows progress in reducing water consumption. Consequently, companies would benefit by paying for a smaller volume of water, and being charged a lower rate for the water they do use. Additionally, one of the carbon neutral companies we talked to discussed the possibility of an incentive program for becoming carbon neutral certified. The carbon neutrality program in particular requires a comprehensive analysis of a company's resource use and waste production using a number of environmental indicators. We believe CICR should lobby to make more incentive programs such as these available to the companies of Costa Rica.

5.5 – Recommendation 5: CICR should investigate the lack of reporting of environmental indicators for the Premio Excelencia Program

We recommend that CICR conduct a study to investigate why many member companies fail to report environmental indicators through CICR's Premio Excelencia program. Finding 7 showed that the low level of participation is not likely due to low availability of data, as over 90% of the CICR member companies who participated in our survey collect at least some of the required information to participate in the environmental sections.

Potential explanations for why companies fail to report on this environmental data include a fear of disclosing negative practices, and concern with being compared to other companies (see Section 4.7). The Premio Excelencia program, however, takes specific measures to alleviate these concerns by assuring confidentiality and by publishing environmental data using percentages as opposed to raw numbers. The Premio Excelencia program offers clear benefits to companies by providing a unique opportunity to confidentially compare themselves to other Costa Rican companies. We believe another possible explanation for the low reporting rate is that companies may be discouraged to participate if they don't see themselves in the gold or platinum categories of the pyramid shown in Recommendation 1.

Because the Premio Excelencia was not the focus of our project, we suggest that a future study should aim to identify the reasons why companies are not taking advantage of this program. This study should also aim to provide solutions to the barriers that might be preventing companies from participating.

5.6 – Summary

Our recommendations were created with the purpose of assisting CICR in their efforts to promote the use of environmental indicators within their member companies. These recommendations call upon CICR to provide resources, such as specific trainings and workbooks, to their member companies. In order to ensure that these resources are tailored to the needs of different companies, we recommended that CICR also adopt a classification system for their member companies based upon level of environmental performance. The environmental data that companies report to the Premio Excelencia would enable CICR to more easily classify their member companies. Therefore, we also recommend that CICR investigate the reasons why many of their member companies are not submitting this information. Lastly, to further promote the use of environmental indicators, we recommend that CICR lobby the Costa Rican government to create more incentive programs for companies to measure their environmental impact. Through these actions, CICR could make great strides toward promoting the use of indicators throughout the industrial sector of Costa Rica.

Chapter 6: Conclusions

Our project supported CICR in their mission to "Promote the sustainable development of the industrial sector and support the competitiveness of our associated companies." The goal of this project was to assist CICR in promoting the use of environmental indicators in Costa Rican companies by better understanding the benefits, barriers, and best practices of their use. To accomplish our goal, data were collected through interviews and surveys with both environmental experts and company representatives. The results of this research, paired with our literature review, informed our results and a series of recommendations.

This work has identified barriers Costa Rican companies encounter when trying to use environmental indicators, and has detailed actions CICR can take to help its member companies. We intend for these results to help increase the overall environmental sustainability of the industrial sector within Costa Rica. As Costa Rica is seen as an international example for sustainability, we hope that Costa Rican industry can set a greater standard for other companies on a global stage. Negative environmental impacts affect communities around the world, and minimizing industrial environmental impact helps reduce these negative effects on society. Our project can help companies better measure and ultimately reduce their environmental impacts, which is necessary for a sustainable future.

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Appendix A: Full Environmental Indicator List

Indicator	Category	Description	Unit	Applicability	Source
Location and size of land owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas	Biodiversity	Land of operational sites owned, leased, managed in, located in, adjacent to, or that contain protected areas and areas of high biodiversity value outside protected areas.	Area in kmˆ2 and the attributes of the protected area	Core	GRI
Description of significant impacts of activities, products, and services on biodiversity in protected areas and areas of high biodiversity value outside protected areas	Biodiversity	Describing the nature of significant direct and indirect impacts on biodiversity with reference to construction/use of manufacturing plants, mines and transport infrastructure, pollution, introduction of invasive species, pests or pathogens, reduction of species, habitat conversion, and changes in ecological processes outside the natural range of variation. Include the effect on species, the extent of the area impacted, duration of impacts the reversibility/irreversibility of the impacts.	Qualitative assessment	Core	GRI
Habitats restored or protected	Biodiversity	The size and location of all habitat protected areas and/or restored areas (in hectares), and whether the success of the restoration measure was/is approved by independent external professionals	Area in kmˆ2	Additional	GRI

Indicator	Category	Description	Unit	Applicability	Source
Strategies, current actions, and future plans for managing impacts on biodiversity	Biodiversity	Report the organization's strategy for achieving its policy on biodiversity management including integration of biodiversity consideration in analytical tools such as environmental site impact assessments, methodology for establishing risk exposure to biodiversity, setting specific targets and objectives, monitoring processes and public reporting	Qualitative assessment	Additional	GRI
Number of IUCN Red List species and national conservation list species with habitats in areas affected by operations, by level of extinction risk	Biodiversity	Report the number of species in habitats identified as affected by level of extinction risk (e.g. critically endangered, endangered, vulnerable, near threatened or least concern)	Quantity by Category of extinction risk	Additional	GRI
Monetary value of significant fines and total number of non-monetary sanctions for non-compliance with environmental laws and regulations	Compliance	Identify any fines or taxes as a results of non-compliance with international declarations/conventions/treaties, and national, sub-national, regional, and local regulations	In company's usual currency (e.g. USD)	Core	GRI
Total number and volume of significant spills	Contamination	Identify the location, volume, and material of spills as a result of company processes. Qualitatively assess the impact of these spills	Volume in cubic meters of spills	Core	GRI
Chemical Oxygen Demand (COD) to Surface Water	Contamination	Total amount of oxygen required for the chemical oxidation of compounds in all water effluents	in metric tons of oxygen	Business-specific	WBCSD

Indicator	Category	Description	Unit	Applicability	Source
Total direct and indirect greenhouse gas emissions	Emissions	Identify direct and indirect emissions of greenhouse gases from all sources including generation of heat, electricity and steam, combustion processes such as flaring, physical or chemical processing, transportation of materials, products and wastes, venting, and fugitive emissions	Tons of CO2 equivalents	Core	GRI
Other relevant indirect greenhouse gas emissions	Emissions	The greenhouse gas emissions from indirect activity not including electricity, hear, or steam	Tons of CO2 equivalents	Core	GRI
Initiatives to reduce greenhouse gas emissions and reductions achieved	Emissions	Identify all reductions in emissions sources and attribute them to either mandatory or voluntary initiatives and report the reductions due to explicit initiatives	Tons of CO2 equivalents and qualitative	Additional	GRI
Emissions of ozone-depleting substances	Emissions	Emissions of substances covered in Annexes A, B, C, and E of the Montreal Protocol on substances that Deplete the Ozone Layer due to production (Substances Produced – Substances Destroyed by Technology – Substances used entirely as feedstock in the manufacture of other chemicals)	In tons and tons of CFC-11 equivalent	Core	GRI
NOx, SOx, and other significant air emissions by type	Emissions	Direct measurement of emissions, calculations or estimations should be used to determine the mass of emissions of N0x, S0x, Persistent Organic Pollutants (POP), Volatile Organic Components (VOC), Hazardous Air Pollutants (HAP), Stack and Fugitive emissions, Particulate Matter (PM) and other standard categories of emissions identified by regulations	Mass (kg) of pollutant by type	Core	GRI

Indicator	Category	Description	Unit	Applicability	Source
Ozone Depleting Substance (ODS) Emissions	Emissions	Amount of ODS emissions to air from processes and losses/replacement from containments (chillers)	In metric tons of CFC11 equivalents	General	WBCSD
Greenhouse Gas (GHG) Emissions	Emissions	Amount of GHG emissions to air from fuel combustion, process reactions and treatment processes, including CO2, CH4, N20, HFCs, PFCs and SF6 (excluding GHG emissions released in generation of purchased electricity)	In metric tons of CO2 equivalents	General	WBCSD
Acidification Emissions to Air	Emissions	Amount of acid gases and acid mists emitted to air (including NH3, HCl, HF, NO2, SO2 and sulfuric acid mists) from fuel combustion, process reactions and treatment processes	In metric tons of SO2 equivalents	General	WBCSD
Priority Heavy Metals (PHM) Emissions to Surface Water	Emissions	Total aquatic release of sum of heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn) and their compound to water	in metric tons of Cu equivalents	Business-specific	WBCSD
Photochemical Oxidant Creation (POC)	Emissions	VOC (excluding methane) and N0x releases	in metric tons of VOX & N0x or ethylene equivalents	Business-specific	WBCSD
Eutrophication Emissions to Surface Water	Emissions	Total aquatic release of phosphorous and nitrogen compounds	in metric tons of phosphorous equivalents	Business-specific	WBCSD
GHG Emissions from Purchased Electricity	Emissions	GHG emissions released by the supplier of purchased electricity	In metric tons of CO2 equivalents	Business-specific	WBCSD
Emissions to air intensity	Emissions	The total amount of contaminants emitted to air sources per GDP	Tons per monetary output (currency)	Economy-Wide	UN ESCAP
GHG emissions to air intensity	Emissions	The total amount energy from fuel per GDP	Joules per monetary output (currency)	Sectorial	UN ESCAP

Indicator	Category	Description	Unit	Applicability	Source
CO2 Intensity	Emissions	The total amount of CO2 emitted to air per GDP	Tons per monetary output (currency)	Sectorial	UN ESCAP
CH4 Intensity	Emissions	The total amount of CH4 emitted to air per GDP	Tons per monetary output (currency)	Sectorial	UN ESCAP
Direct energy consumption by primary energy source	Energy	The total direct energy consumption is the direct primary energy consumed and produced less he direct primary energy sold	Joules or multiples of joules	Core	GRI
Indirect energy consumption by primary energy source	Energy	The total weight or volume of non-renewable materials used and direct materials used	Joules or multiples of joules	Core	GRI
Energy saved due to conservation and efficiency improvements	Energy	The total energy saved by efforts to reduce energy usage and increase energy efficiency such as process redesign, conversion and retrofitting of equipment and changes in personnel behavior	Joules or multiples of joules	Additional	GRI
Initiatives to provide energy-efficient or renewable energy based products and services	Energy	Quantified reductions in the energy requirements of products and services as direct results of explicit initiatives	Joules or multiples of joules for energy reductions or percentage decreases	Additional	GRI
Initiatives to reduce indirect energy consumption and reductions achieved	Energy	Reduction of indirect energy use has been reduced for use of energy intensive materials, subcontracted production, business related travel, and employee commuting as direct results of explicit initiatives	Joules or multiples of joules for energy reductions or percentage decreases	Additional	GRI

Indicator	Category	Description	Unit	Applicability	Source
Energy Consumption	Energy	Total sum of energy consumes (equals energy purchases minus energy sold to others for their use), including: electricity and district heat, fossil fuels, other fuel based energy, and non-fuel based energy	In gigajoules (or other appropriate multiplier of joules)	General	WBCSD
Energy Intensity	Energy	Total energy consumed from all sources including electricity, oil, gas, coke, coal, wind, nuclear, and other sources per unit of production/service (can be tons of product, units of product, dollars of sales, megawatt hours, or rea of floor space)	Joules of energy per unit product/service	Core	NRTEE
Life-cycle Energy Intensity	Energy	The sum of the energy consumed during all of the phases of the product or service life- cycle, from the extraction and processing of input materials and energy, through to the eventual disposal of the product per unit production/service (can be tons of product, units of product, dollars of sales, megawatt hours, or rea of floor space)	Joules of energy per unit product/service	Complimentary	NRTEE
Total Excess Energy Generated	Energy	The excess energy generated within a product or service entity that is not used within the facility but is used by or sold to others (the excess energy indicator applies to companies that produce energy as a co-product)	Joules of energy	Complimentary	NRTEE
Energy Intensity	Energy	The total amount of energy consumed per GDP	Joules per monetary output (currency)	Economy-Wide	UN ESCAP
Fuel Intensity	Energy	The total amount of CO2 emitted to air per GDP	Tons per monetary output (currency)	Sectorial	UN ESCAP

Indicator	Category	Description	Unit	Applicability	Source
Total environmental protection expenditures and investments by type	Expenditures	Report the total environmental protection expenditures broken down by waste disposal, emissions treatment, and remediation costs and reinvention and environmental management costs	In company's usual currency (e.g. USD)	Additional	GRI
Land use Intensity	Land	The total amount of land used per GDP	kmˆ2 per monetary output (currency)	Economy-Wide	UN ESCAP
Materials Used by Weight or Volume	Materials	The total weight or volume of: Non-renewable materials used and direct materials used	By volume or weight	Core	GRI
Percentage of materials used that are recycled input materials	Materials	Recycled input materials used per total input materials used	Percentage (by volume or weight)	Core	GRI
Material Consumption	Materials	Sum of weight of all materials purchased or obtained from other sources, including: raw materials for conversion, other process materials (such as catalysts and solvents), pre- or semi-manufactured goods and parts excluding packaging, water consumption, and materials used for energy purposes	In metric tons	General	WBCSD
Material Intensity	Materials	The total amount materials used directly per GDP	Direct Material Output per monetary output (currency)	Economy-Wide	UN ESCAP
Initiatives to mitigate environmental impacts of products and services, and extent of impact mitigation	Overall	Report initiatives in the reporting period to mitigate the most significant environmental impacts of products/service groups in relation to materials use, water use, effluents, emissions, noise and waste and quantify the impact of explicit initiatives	Dependent on initiative	Core	GRI

Indicator	Category	Description	Unit	Applicability	Source
Percentage of products sold and their packaging materials that are reclaimed by category	Packaging	The percent of products reclaimed is defined as the ratio of products and packaging reclaimed to the total products sold	Percentage	Core	GRI
Packaging	Packaging	Packaging from purchases goods and for products	in metric tons	Business-specific	WBCSD
Significant environmental impacts of transporting products and other goods and materials used for the organization's operations, and the transporting members of the workforce	Transport	Identify the significant environmental impacts of the modes of transportation including energy use, emissions, effluents, waste, noise, and spills.	Dependent on focus of environmental impact	Additional	GRI
Quantity	Value	Physical Measure or count of product or services produced, delivered or sold to customers	As appropriate for the particular business, such as number or mass	General	WBCSD
Net Sales	Value	Total recorded sales less sales discounts and sales returns and allowances	In company's usual currency (e.g. USD)	General	WBCSD
Net Profit/Earnings/Income	Value	Net sales minus all expenses for the period including: cost of goods sold; selling, general and administrative expenses; technology expenses; R&D costs; amortization and adjustment of intangible assets; restructuring and special charges; interest expenses; other expenses	In company's usual currency (e.g. USD)	General	WBCSD
EBIT	Value	Profit before interest expense and income tax	In company's usual currency (e.g. USD)	Business-specific	WBCSD
Value Added	Value	Net sales minus costs of goods and services purchased	In company's usual currency (e.g. USD)	Business-specific	WBCSD

Indicator	Category	Description	Unit	Applicability	Source
Gross Margin	Value	Net sales minus costs of goods and services sold	In company's usual currency (e.g. USD)	Business-specific	WBCSD
Total weight of waste by type and disposal method	Waste	Identify all hazardous and non-hazardous wastes (less waste water) and record, calculate, or estimate the mass of waste generated and the disposal method used to dispose of waste including composting, reuse, recycling, recovery, incineration, landfill, deep well injection, on site storage or other methods.	Mass in tons of waste	Core	GRI
Weight of transported, imported, exported, or treated waste deemed hazardous	Waste	Weight of transported, imported, exported, or treated waste deemed hazardous under the terms of the Basel Convention Annex I, II, III, and VIII, and percentage of transported waste shipped internationally	Mass in kg or tons of wastes	Additional	GRI
Total Waste	Waste	Total amount of substances or objects destined for disposal	In metric tons	General	WBCSD
Waste to Landfill	Waste	Wastes from processes, treatments, and packaging, disposed of by landfill	in metric tons	Business-specific	WBCSD
Waste to Incineration	Waste	Wastes from processes, treatments, and packaging, disposed of by incineration	in metric tons	Business-specific	WBCSD
Waste Intensity	Waste	The total material entering the process minus the material the ends up in the product and co-products per unit production/service (can be tons of product, units of product, dollars of sales, megawatt hours, or rea of floor space)	kg waste per unit product/service	Core	NRTEE

Indicator	Category	Description	Unit	Applicability	Source
Waste Utilization	Waste	A percentage of the waste a company generates that is reused for some purpose as a fraction of the total waste generated	Percentage	Complimentary	NRTEE
Solid Waste Intensity	Waste	The total amount of solid wastes generated per GDP	Tons per monetary output (currency)	Sectorial	UN ESCAP
Total water withdrawal by source	Water	The total volume of water withdrawn from surface water, ground water, rain water, waste water, and municipal water supplies	Volume in cubic meters	Core	GRI
Water sources significantly affected by withdrawal of water	Water	Identify water sources significantly affected by water withdrawal defined as (a) Withdrawals that account for an average of 5 percent or more of the annual average volume of a given water body (b) Withdrawals from water bodies that are recognized by professionals to be particularly sensitive due to their relative size, function, or status as a rare, threatened, or endangered system or (c) Any withdrawal from a Ramsar-listed wetland or any other nationally or internationally proclaimed conservation area regardless of the rate of withdrawal	Volume in cubic meters	Additional	GRI
Percentage and total volume of water recycled and reused	Water	The volume of water recycled/reused based on the volume of water demand satisfied by recycled /reused water rather than further withdrawals	Volume in cubic meters and percentage	Additional	GRI

Indicator	Category	Description	Unit	Applicability	Source
Total water discharge by quality and destination	Water	The planned and unplanned water discharges broken down by destination, treatment and whether the water was reused by another organization. Additionally if effluents are discharged in water stream Biological Oxygen Demand (BOD) and Total Suspended Solids (TSS) or other such data should be recorded as well	Volume in cubic meters of water	Core	GRI
Identity, size, protected status, and biodiversity value of water bodies and related habitats significantly affected by the reporting organization's discharges of water and runoff	Water	Identify water sources significantly affected by water discharged defined as (a) Withdrawals that account for an average of 5 percent or more of the annual average volume of a given water body (b) Withdrawals from water bodies that are recognized by professionals to be particularly sensitive due to their relative size, function, or status as a rare, threatened, or endangered system or (c) Any withdrawal from a Ramsar-listed wetland or any other nationally or internationally proclaimed conservation area regardless of the rate of withdrawal	The size of the body of water in cubic meters and qualitative data	Additional	GRI
Water Consumption	Water	Sum of all fresh water purchased from public supply, or obtained from surface or ground water sources (including water for cooling purposes)	In cubic meters	General	WBCSD
Water Intensity	Water	Total water taken in per unit of production/service (can be tons of product, units of product, dollars of sales, megawatt hours, or rea of floor space)	mˆ3 of water per unit product/service	Core	NRTEE

Indicator	Category	Description	Unit	Applicability	Source
Water Discharge Intensity	Water	The total water discharged per unit of production/service (can be tons of product, units of product, dollars of sales, megawatt hours, or rea of floor space)	mˆ3 of water per unit product/service	Complimentary	NRTEE
Water Intensity	Water	The total amount of water consumed per GDP	Volume (mˆ3) per monetary output (currency)	Economy-Wide	UN ESCAP
Emission to waters intensity	Water	The total amount of contaminants emitted to water sources per GDP	Tons per monetary output (currency)	Economy-Wide	UN ESCAP
BOD Intensity	Water	The total amount of biochemical oxygen demand in wastewater per GDP	Tons per monetary output (currency)	Sectorial	UN ESCAP

Appendix B: Reduced Environmental Indicator List

Indicator	Category	Description	Unit
Location and size of lands near areas of high biodiversity	Biodiversity	Land of operational sites owned, leased, managed in, located in, adjacent to, or that contain protected areas and areas of high biodiversity value outside protected areas.	Area in km^2 and the attributes of the protected area
Description of significant impacts of activities, products, and services on biodiversity in protected areas and areas of high biodiversity value outside protected areas	Biodiversity	Describing the nature of significant direct and indirect impacts on biodiversity with reference to construction/use of manufacturing plants, mines and transport infrastructure, pollution, introduction of invasive species, pests or pathogens, reduction of species, habitat conversion, and changes in ecological processes outside the natural range of variation. Include the effect on species, the extent of the area impacted, duration of impacts the reversibility/irreversibility of the impacts.	Qualitative assessment
Habitats restored or protected	Biodiversity	The size and location of all habitat protected areas and/or restored areas, and whether the success of the restoration measure was/is approved by independent external professionals	Area in km^2
Strategies, current actions, and future plans for managing impacts on biodiversity	Biodiversity	Report the organization's strategy for achieving its policy on biodiversity management including integration of biodiversity consideration in analytical tools such as environmental site impact assessments, methodology for establishing risk exposure to biodiversity, setting specific targets and objectives, monitoring processes and public reporting	Qualitative assessment
Number of IUCN Red List species and national conservation list species with habitats in areas affected by operations, by level of extinction risk	Biodiversity	Report the number of species in habitats identified as affected by level of extinction risk (e.g. critically endangered, endangered, vulnerable, near threatened or least concern)	Quantity by category of extinction risk

Indicator	Category	Description	Unit
Monetary value of significant fines and total number of non-monetary sanctions for non-compliance with environmental laws and regulations	Compliance	Identify any fines or taxes as a results of non-compliance with international declarations/conventions/treaties, and national, sub-national, regional, and local regulations	In company's usual currency (e.g. USD)
Total number and volume of significant spills	Contamination	Identify the location, volume, and material of spills as a result of company processes. Qualitatively assess the impact of these spills	Volume in cubic meters of spills
Chemical Oxygen Demand (COD) to Surface Water	Contamination	Total amount of oxygen required for the chemical oxidation of compounds in all water effluents	Metric tons of oxygen
Emission to waters intensity	Contamination	The total amount of contaminants emitted to water sources per unit (product, service, revenue, etc.)	Tons per unit
Total direct and indirect greenhouse gas emissions	Emissions	Identify direct and indirect emissions of greenhouse gases from all sources including generation of heat, electricity and steam, combustion processes such as flaring, physical or chemical processing, transportation of materials, products and wastes, venting, and fugitive emissions	Tons of CO2 equivalents
Emissions of ozone-depleting substances	Emissions	Emissions of substances covered in Annexes A, B, C, and E of the Montreal Protocol on substances that Deplete the Ozone Layer due to production (Substances Produced less Substances Destroyed by Technology and Substances used entirely as feedstock in the manufacture of other chemicals)	In tons and tons of CFC-11 equivalent
NOx, SOx, and other significant air emissions by type	Emissions	Direct measurement of emissions, calculations or estimations should be used to determine the mass of emissions of N0x, S0x, Persistent Organic Pollutants (POP), Volatile Organic Components (VOC), Hazardous Air Pollutants (HAP), Stack and Fugitive emissions, Particulate Matter (PM) and other standard categories of emissions identified by regulations	Mass (kg) of pollutant by type
Priority Heavy Metals (PHM) Emissions to Surface Water	Emissions	Total aquatic release of sum of heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn) and their compound to water	Metric tons of Cu equivalents

Indicator	Category	Description	Unit
Photochemical Oxidant Creation (POC)	Emissions	VOC (excluding methane) and N0x releases	Metric tons of VOX & N0x or ethylene equivalents
Eutrophication Emissions to Surface Water	Emissions	Total aquatic release of phosphorous and nitrogen compounds	Metric tons of phosphorous equivalents
GHG Emissions from Purchased Electricity	Emissions	GHG emissions released by the supplier of purchased electricity	Metric tons of CO2 equivalents
Emissions to air intensity	Emissions	The total amount of contaminants emitted to air sources per unit (product, service, revenue, etc.)	Tons per unit
CO2 Intensity	Emissions	The total amount of CO2 emitted to air per unit (product, service, revenue, etc.)	Tons per unit
CH4 Intensity	Emissions	The total amount of CH4 emitted to air per unit (product, service, revenue, etc.)	Tons per unit
Direct energy consumption by primary energy source	Energy	The total direct energy consumption is the direct primary energy consumed and produced less the direct primary energy sold	Joules or multiples of joules
Indirect energy consumption by primary energy source	Energy	The total amount of indirect energy used by indirect non-renewable sources and indirect renewable sources in terms of intermediate energy	Joules or multiples of joules
Energy saved due to conservation and efficiency improvements	Energy	The total energy saved by efforts to reduce energy usage and increase energy efficiency such as process redesign, conversion and retrofitting of equipment and changes in personnel behavior	Joules or multiples of joules
Energy Consumption	Energy	Total sum of energy consumed (equals energy purchases minus energy sold to others for their use), including: electricity and district heat, fossil fuels, other fuel based energy, and non-fuel based energy	In gigajoules (or other appropriate multiplier of joules)
Life-cycle Energy Intensity	Energy	The sum of the energy consumed during all of the phases of the product or service life- cycle, from the extraction and processing of input materials and energy, through to the eventual disposal of the product per unit production/service (can be tons of product, units of product, dollars of sales, megawatt hours, or area of floor space)	Joules of energy per unit product/service

Indicator	Category	Description	Unit
Total Excess Energy Generated	Energy	The excess energy generated within a product or service entity that is not used within the facility but is used by or sold to others (the excess energy indicator applies to companies that produce energy as a co-product)	Joules of energy
Total environmental protection expenditures and investments by type	Expenditures	Report the total environmental protection expenditures broken down by waste disposal, emissions treatment, and remediation costs and reinvention and environmental management costs	In company's usual currency (e.g. USD)
Initiatives to reduce greenhouse gas emissions and reductions achieved	Initiatives	Identify all reductions in emissions sources and attribute them to either mandatory or voluntary initiatives and report the reductions due to explicit initiatives	Tons of CO2 equivalents and qualitative
Initiatives to provide energy-efficient or renewable energy based products and services	Initiatives	Quantified reductions in the energy requirements of products and services as direct results of explicit initiatives	Joules or multiples of joules for energy reductions or percentage decreases
Initiatives to reduce indirect energy consumption and reductions achieved	Initiatives	Reduction of indirect energy use has been reduced for use of energy intensive materials, uncontracted production, business related travel, and employee commuting as direct results of explicit initiatives	Joules or multiples of joules for energy reductions or percentage decreases
Initiatives to mitigate environmental impacts of products and services, and extent of impact mitigation	Initiatives	Report initiatives in the reporting period to mitigate the most significant environmental impacts of products/service groups in relation to materials use, water use, effluents, emissions, noise and waste, and quantify the impact of explicit initiatives	Dependent on initiative
Land use Intensity	Land	The total amount of land used per unit (product, service, revenue, etc.)	km^2 per unit
Materials Used by Weight or Volume	Materials	The total weight or volume of: Non-renewable materials used and direct materials used	By volume or weight
Percentage of materials used that are recycled input materials	Materials	Recycled input materials used per total input materials used	Percentage (by volume or weight)

Indicator	Category	Description	Unit
Percentage of products sold and their packaging materials that are reclaimed by category	Packaging	The percent of products reclaimed is defined as the ratio of products and packaging reclaimed to the total products sold	Percentage
Packaging	Packaging	Packaging from purchased goods and for products	In metric tons
Fuel Intensity	Transport	The total amount of fuel used for transportation purposes per unit	Volume per unit
Significant environmental impacts of transporting products and other goods and materials used for the organization's operations, and the transporting members of the workforce	Transport	Identify the significant environmental impacts of the modes of transportation including energy use, emissions, effluents, waste, noise, and spills.	Dependent on focus of environmental impact
Total weight of waste by type and disposal method	Waste	Identify all hazardous and non-hazardous wastes (less waste water) and record, calculate, or estimate the mass of waste generated and the disposal method used to dispose of waste including composting, reuse, recycling, recovery, incineration, landfill, deep well injection, on site storage or other methods.	Mass in tons of waste
Weight of transported, imported, exported, or treated waste deemed hazardous	Waste	Weight of transported, imported, exported, or treated waste deemed hazardous under the terms of the Basel Convention Annex I, II, III, and VIII, and percentage of transported waste shipped internationally	Mass in kg or tons of wastes
Waste Utilization	Waste	A percentage of the waste a company generates that is reused for some purpose as a fraction of the total waste generated	Percentage
Solid Waste Intensity	Waste	The total amount of solid wastes generated per unit (product, service, revenue, etc.)	Tons per unit
Total water withdrawal by source	Water	The total volume of water withdrawn from surface water, ground water, rain water, wastewater, and municipal water supplies	Volume in cubic meters

Indicator	Category	Description	Unit
Water sources significantly affected by withdrawal of water	Water	Identify water sources significantly affected by water withdrawal defined as (a) Withdrawals that account for an average of 5 percent or more of the annual average volume of a given water body (b) Withdrawals from water bodies that are recognized by professionals to be particularly sensitive due to their relative size, function, or status as a rare, threatened, or endangered system or (c) Any withdrawal from a Ramsar-listed wetland or any other nationally or internationally proclaimed conservation area regardless of the rate of withdrawal	Volume in cubic meters
Percentage and total volume of water recycled and reused	Water	The volume of water recycled/reused based on the volume of water demand satisfied by recycled /reused water rather than further withdrawals	Volume in cubic meters and percentage
Total water discharge by quality and destination	Water	The planned and unplanned water discharges broken down by destination, treatment and whether the water was reused by another organization. Additionally if effluents are discharged in water stream Biological Oxygen Demand (BOD) and Total Suspended Solids (TSS) or other such data should be recorded as well	Volume in cubic meters of water

Appendix C: List of Environmental Consultants Interviewed

Company Name	Interviewee Name	Position
CICR	Agustin Rodriguez Carvajal	Environmental Consultant
CICR	Sergio Arias	Head of Premier Excelencia
CICR	Emil de la Rocha Valverde	Energy and Environmental Consultant
AED	Pablo Rojas	Environmental Director
ALIARSE	Natalia Gomboa	Coordinator of Environmental Projects

Appendix D: Environmental Consultant Interview Guide

"We are part of a four-person project team from Worcester Polytechnic Institute in the United States, and we are working with CICR to help companies measure their environmental impact to make more informed decisions. To do this, we first spent seven weeks in the fall researching environmental indicators used elsewhere in the world. Now, we have seven weeks here in Costa Rica to determine which of these indicators are a good fit for Costa Rican companies. The information that we obtain from this interview will help us in developing a list of environmental indicators that are useful and relevant to companies in Costa Rica.

1. What is your name and position?
   (a) How long have you been working in the field?
2. What do you think are the most important "categories" that Costa Rican companies should measure? (For example water, emissions, waste, etc.)
3. From your experience, what are the most common environmental indicators that companies use and why?
   (a) What indicators from our list (list of 45) seem the most relevant to Costa Rican companies and why?
   (b) Are there any important indicators that were not included in our list?
4. For the Primera Excelencia (an annual report that companies of CICR have the option to complete), there are five environmental indicators (water consumed, electric energy used, fuel consumption, solid waste generated, and carbon dioxide emission intensity). Do you think these are the only 5 things companies should use or are there more?
5. What benefits do you see for companies to use environmental indicators?
   (a) Are there certain laws that companies could benefit from by using indicators to monitor certain areas (i.e. tracking water usage can help avoid water tariff)?
6. What challenges or obstacles do you foresee companies facing in their efforts to using environmental indicators?
   (a) Money?
   (b) Educational resources on how to calculate or what to measure?
   (c) Motivations / incentives?
   (d) Knowledge about usefulness?
   (e) Knowledge about options?
7. Do you think there are different barriers for different size companies? (SME vs large) Why?
8. Do you have any more comments?

Appendix E: Survey Questions

Q1 Esta encuesta solicita información sobre los datos de impacto ambiental que su empresa recopila. Le agradecemos por tomarse el tiempo para considerar cuidadosamente sus respuestas a cada pregunta. La encuesta le preguntará primero si recopila cualquier información relacionada con una categoría ambiental en particular. Si selecciona Sí, se mostrarán preguntas más detalladas sobre tipos específicos de datos. Estas preguntas se presentarán en una selección de todas las respuestas que se aplican formato. Por favor seleccione No sabe si no está seguro, las preguntas detalladas serán presentadas para su revisión. La última pregunta le da la oportunidad de informarnos sobre los datos que su empresa recolecta que no incluimos en esta encuesta. Agradecemos su ayuda con nuestro proyecto!

Q2 ¿Cuál es tu nombre?

Q3 ¿Cuál es el nombre de su empresa?

Q4 ¿Cuál es su rol o cargo en su empresa?

Q5 ¿Recoge usted algún dato relacionado con el agua?

- ◦ Sí
- ◦ No
- ◦ No lo sé

Q6 ¿Qué datos recopila sobre el agua? (Seleccione todas las que correspondan)

- ☐ Volumen de agua utilizada de las aguas superficiales
- ☐ Volumen de agua utilizada de las aguas subterráneas
- ☐ Volumen de agua utilizada del agua de lluvia
- ☐ Volumen de agua utilizada de las aguas residuales
- ☐ Volumen de agua utilizada del suministro de agua municipal
- ☐ Volumen de agua utilizada de fuentes protegidas o en riesgo
- ☐ Volumen de agua reciclada o reutilizada
- ☐ Volumen de aguas residuales producidas
- ☐ Volumen y calidad del agua descargada a la corriente de agua (medición del Total de Sólidos Suspendidos, Demanda Biológica de Oxígeno, etc.)
- ☐ Otro: _____

Q7 ¿Recoge usted algún dato relacionado con los residuos?

- ◦ Sí
- ◦ No
- ◦ No lo sé

Q8 ¿Qué datos recoge usted relacionados con los residuos? (Seleccione todas las que correspondan)

☐ Masa de residuos totales generados

☐ Masa de residuos gestionados por compostaje

☐ Masa de residuos gestionados por reutilización

☐ Masa de residuos gestionados por reciclaje

☐ Masa de residuos gestionados por recuperación

☐ Masa de residuos gestionados por incineración

☐ Masa de residuos gestionados por vertedero

☐ Masa de residuos gestionados por almacenamiento en sitio

☐ Masa de residuos que se reutilizan para algún propósito

☐ Masa de residuos sólidos generados

☐ Masa de residuos especiales

☐ Masa de residuos peligrosos y/o tóxicos

☐ Tipos de residuos generados

☐ Otro: _____

Q9 ¿Recopila datos relacionados con la energía?

◦ Sí

◦ No

◦ No lo sé

Q10 ¿Qué datos recopila sobre energía? (Seleccione todas las que correspondan)

☐ Suma total de energía consumida

☐ Cantidad de exceso de energía generada que no es utilizada por la instalación

☐ Suma de la energía consumida durante todas las fases del ciclo de vida del producto

☐ Energía total ahorrada por esfuerzos para reducir el uso de energía y aumentar la eficiencia

☐ Cantidad total de energía indirecta utilizada

☐ Otro: _____

Q19 ¿Recopila datos relacionados con la contaminación?

◦ Sí

◦ No

◦ No lo sé

Q20 ¿Qué datos recoge usted relacionados con la contaminación? (Seleccione todas las que correspondan)

☐ Cantidad total de contaminantes emitidos a las fuentes de agua

☐ Cantidad total de oxígeno requerido para la oxidación química de compuestos en efluentes de agua

☐ Ubicación, volumen y material de derrames como resultado de los procesos de la empresa

☐ Otro: _____

Q21 ¿Recopila datos relacionados con las emisiones?

◦ Sí

◦ No

◦ No lo sé

Q22 ¿Qué datos recopila sobre las emisiones? (Seleccione todas las que correspondan)

☐ Emisiones directas e indirectas de emisiones de gases de efecto invernadero de todas las fuentes

☐ Cantidad total de CH4 emitida al aire

☐ Cantidad total de CO2 emitida al aire

☐ Cantidad total de NOx emitada al aire

☐ Cantidad total de SO4 emitada al aire

☐ Cantidad total de contaminantes emitidos al aire

☐ Emisiones de gases de efecto invernadero liberadas por el proveedor de electricidad comprada

☐ Liberación acuática total de compuestos de fósforo y nitrógeno

☐ Cantidad total de COV (excluyendo el metano)

☐ Total de liberación acuática de la suma de metales pesados (As, Cd, Cr, Cu, Pb, Hg, Bi, Zn)

☐ Emisiones totales producidas

☐ Emisiones totales de sustancias que agotan la capa de ozono

☐ Otro: _____

Q23 ¿Recopila datos relacionados con la biodiversidad?

◦ Sí

◦ No

◦ No lo sé

Q24 ¿Qué datos recopila sobre biodiversidad? (Seleccione todas las que correspondan)

☐ Número de especies en hábitats afectados por la producción de la empresa

☐ Estado de conservación de especies en hábitats afectados por la producción de la empresa

☐ Tamaño y ubicación de todas las áreas protegidas de hábitat o áreas restauradas afectadas por la producción de la empresa

☐ Terrenos de sitios operativos propiedad, arrendados, administrados en, ubicados en, adyacentes a la empresa que

☐ contienen áreas protegidas y áreas de alto valor de biodiversidad

☐ Otro: _____

Q11 ¿Recoge usted algún dato relacionado con el transporte?

◦ Sí

◦ No

◦ No lo sé

Q12 ¿Qué datos recoge usted relacionados con el transporte? (Seleccione todas las que correspondan)

☐ Cantidad total de combustible utilizado

☐ Uso de energía desde el transporte

☐ Emisiones del transporte

☐ Efluentes del transporte

☐ Residuos del transporte

☐ Derrames del transporte

☐ Kilometraje de la flotilla

☐ Otro: _____

Q13 ¿Recopila datos relacionados con el embalaje?

◦ Sí

◦ No

◦ No lo sé

Q14 ¿Qué datos recopila sobre el embalaje? (Seleccione todas las que correspondan)

☐ Cantidad de envases para productos

☐ Cantidad de productos de embalaje recuperados

☐ Cantidad de envases de productos comprados

☐ Otro: _____

Q15 ¿Recoge usted algún dato relacionado con los materiales o las materias primas?

◦ Sí

◦ No

◦ No lo sé

Q16 ¿Qué datos recopila sobre los materiales o las materias primas? (Seleccione todas las que correspondan)

☐ Peso total o volumen de todos los los materiales o las materias primas utilizados

☐ Cantidad de los materiales o las materias primas de entrada que se reciclan

☐ Otro: _____

Q17 ¿Recoge usted algún dato relacionado con la tierra?

◦ Sí

◦ No

◦ No lo sé

Q18 ¿Qué datos recopila sobre la tierra? (Seleccione todas las que correspondan)

☐ Cantidad total de tierra utilizada

☐ Cambio de uso de tierra o suelo

☐ Otro: _____

Q25 ¿Recopila datos relacionados con las iniciativas?

◦ Sí

◦ No

◦ No lo sé

Q26 ¿Qué datos recolecta sobre iniciativas? (Seleccione todas las que correspondan)

☐ Iniciativas relacionadas con la mitigación de impactos ambientales significativos

☐ Reducciones voluntarias en las fuentes de emisiones

☐ Reducción de los requerimientos energéticos

☐ Reducciones del uso indirecto de energía

☐ Otro: _____

Q27 ¿Recoge usted algún dato relacionado con los gastos?

◦ Sí

◦ No

◦ No lo sé

Q28 ¿Qué datos recolecta sobre los gastos? (Seleccione todas las que correspondan)

☐ Gastos de disposición de residuos

☐ Gastos de tratamiento de emisiones

☐ Gastos de los costos de remediación

☐ Gastos de gestión ambiental

☐ Gastos de tratamiento de aguas residuales y lodos

☐ Otro: _____

Q29 ¿Recopila datos relacionados con el cumplimiento?

◦ Sí

◦ No

◦ No lo sé

Q30 ¿Qué datos recopila sobre el cumplimiento? (Seleccione todas las que correspondan)

☐ Multas o impuestos resultantes del incumplimiento de la normativa

☐ Cumplimiento de los límites y requisitos legales

☐ Otro: _____

Q31 ¿Hay datos que recopile relacionados con el impacto ambiental no mencionados en esta encuesta?

Appendix F: List of Companies Interviewed

Designated Company Letter	Industry	Size
A	Chemical	SME
B	Chemicals and Special Waste management	SME
C	Manufacturing	SME
D	Agriculture	Large
E	Medical	Large
F	Food	Large
G	Food	SME

Appendix G: Environmental Manager Interview Guide

Introduction: Appropriate greeting. Introduce ourselves by name. We are part of a four-person project team from Worcester Polytechnic Institute in the United States, and we are working with CICR to help companies measure their environmental impact to make more informed decisions. To do this, we first spent seven weeks in the fall researching environmental indicators used elsewhere in the world. Now, we have seven weeks here in Costa Rica to determine which of these indicators are a good fit for Costa Rican companies. As the environmental manager (production manager) within your company, we are interested to learn from you, your company's approach to data collection related to environmental topics. We previously sent a survey asking about what data you collect, so in this interview we are more interested in the why and how of your data collection practices. We really appreciate you taking the time to help us with our project.

We're assuming for this interview that the company will have filled out the survey before we go interview them. The survey will be mentioned in the initial interview request letter, and the company will be reminded to fill out the survey in followups. We will also bring the survey with us in case they have not completed it or have forgotten what they answered.

Ask the interviewee if they were the one who filled out the survey. If they were not the one who filled out the survey, ask if that individual is available. If not, or if no one filled out the survey, we will have a printed copy of the survey with us, and we will ask the individual to look it over. We will not ask them to complete the survey on the spot, because this could influence answers. However, when we ask the interview questions, we will direct them to the copy of the survey as a reference for their answers.

1. What is your name and title?
2. Can you tell us a little about your company?
   (a) Size/number of employees?
   (b) Business sector?
3. For the data that you currently collect (based on survey responses), how do you collect it?
   (a) Why do you collect this data? Is it for a specific purpose?
   (b) How often do you update your numbers?
4. What challenges have you encountered trying to collect environmental data? Others have identified time, not knowing how to measure the data, cost of actually measuring the data, and no perceived benefit from doing so.
5. Of the environmental categories (water, waste, energy, etc), what is the hardest area to collect data on? Why?
   (a) Cost of measuring equipment
   (b) Time to take and process measurements?
6. Do you believe that all data categories in the survey are relevant to your company's operation? Which ones are/are not relevant? Why are they relevant? Does your company significantly impact some part of that environmental category?

Person taking notes should summarize what we learned. Thank interviewee for their time, leave them with our contact information, make sure we have theirs for follow-up/thank you.

Appendix H: Manager Interview Guide

Introduction: Prior to this interview, we will email the interviewee the list of indicators that we developed after feedback from the ESR committee. We will call them prior to the interview to remind them to look at the list and ask them if they have any questions. We will reference the indicator list in our questions and so it will be useful if they view this list beforehand.

Appropriate greeting. Introduce ourselves by name. Ask if we can record "We are part of a four-person project team from Worcester Polytechnic Institute in the United States, and we are working with CICR to help companies measure their environmental impact to make more informed decisions. To do this, we first spent seven weeks in the fall researching environmental indicators used elsewhere in the world. Are you familiar with environmental indicators? (If yes, continue. If no, explain) Now we are working for seven weeks here in Costa Rica to determine which of these indicators are good fits for Costa Rican companies. As managers and decision makers within your company, we want to learn how you currently use indicators (if you do), and the role that you think they could play for you in your company. We really appreciate you taking the time to help us with our project."

Although this interviewee will (hopefully) not be who completed the survey, we will still bring a paper copy of the survey to the interview with us to serve as a reference. Also, we will bring with us a copy of the indicator list that we finalized after the feedback from the ESR committee to also serve as a reference.

1. What is your name and title?
   (a) Can you tell us a little about your company?
   (b) Size/number of employees?
2. What indicators (if any) do you currently use?
   (a) Why those specifically?
   (b) Do you feel well-informed making decisions using those indicators?
   (c) What types of decisions do those indicators influence?
   (d) If you don't, how do you measure your environmental impact (if at all)?
   (e) What barriers have you encountered (or continue to encounter) in implementing those indicators?
   (f) Financial cost?
   (g) People's time?
   (h) How did you overcome those barriers?
3. What indicators do you foresee having difficulty implementing and why?
   (a) No data for them? Don't see the payoff, is it costly?
   (b) Some indicators won't be especially applicable to all companies/industries - data may not even apply to your business
4. What types of decisions would you want more information for?
   (a) Are these decisions related to the use of specific resources? If so, which ones?
5. What would motivate you to utilize more indicators?
   (a) They aren't going to come for free, but using them could help you save money (can't measure it, can't improve it). How much of a benefit do you need to see to justify adopting an indicator?
6. Would you feel well-informed to make decisions based upon the shortlist of indicators we propose? (Decisions like where to invest in more efficient technologies, areas to target for reduced consumption, etc) Do you feel like any particular indicators stand out as

particularly useful?
   (a) Do you perceive that these would be credible?
7. Are you familiar with the concept of normalization? (If not, explain that a common way companies use indicators to gauge their progress is to measure environmental data per product, revenue, or service). Many of these indicators could vary significantly with the size of company/production levels/output/etc. Do you see this as effective?
   (a) If so, what do you think would be the most appropriate normalization factor for your company? (Production output, revenue, etc)

Person taking notes should summarize what we learned. Thank interviewee for their time, leave them with our contact information, make sure we have theirs for follow-up/thank you.